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GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station

PROJECT INITIATION

Date: August 22, 1972

Project Title: Implementation of Alumina from Kaolin Potentials

Project No.: A-1458

Project Director: W. C. Ward, Jr.

Sponsor: Georgia Department of Industry and Trade

Effective . . . July 31, 1972 . . . Estimated to run until: July 30, 1973

Type Agreement: Industrial Development Research Project . . . Amount: $ 15,000

REPORTS: Quarterly, letter-type progress reports (10 copies each).
Final (15 copies)

CONTACT PERSON: Mr. Harold A. Dye
Georgia Department of Industry and Trade
P.O. Box 38097
Atlanta, Georgia 30303

* Plus EES Cost Sharing Contribution of $1,000; Account E-400-110

Assigned to . . . Industrial Development . . . Division

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RA-52

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION

no action req'd

Date: November 10, 1978

Project Title: Implementation of Alumina From Kaolin Potentials

Project No: A-1458

Project Director: W. C. Ward, Jr.

Sponsor: Georgia Department of Industry and Trade

Effective Termination Date: 10/31/78

Clearance of Accounting Charges: 10/31/78

Grant/Contract Closeout Actions Remaining:

- X Final Invoice ~~and Closing Documents~~
- _ Final Fiscal Report
- _ Final Report of Inventions
- _ Govt. Property Inventory & Related Certificate
- _ Classified Material Certificate
- _ Other ____________

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CA-4 (3/76)

A-1458

UPDATE OF COSTS AS OF FEBRUARY 12, 1973, OF INFORMATION
RE "ALUMINA FROM KAOLIN POTENTIALS."

The above mentioned report was submitted by the Engineering Experiment Station of Georgia Institute of Technology for printing on May 1, 1972 with a cut-off of information somewhat earlier. Pilot plant construction and operating cost estimates were obtained by updating unofficial U. S. Bureau of Mines estimates, plus an add-on both for projected inflation until July 1, 1973, or shortly thereafter, and to be sure there was enough money to cover the project if Congressional action were needed. Unofficial cost estimates obtained from the U. S. Bureau of Mines were based on construction and operation of a 5 ton per day of alumina from kaolin pilot plant, using a modified Nuvalon process for a total time period of up to five years. This also included laboratory evaluation of other existing or known processes to obtain an optimum process for bid specifications. It was recognized that the eventual process to be used for bid specifications would not necessarily be the Nuvalon process. Until evaluations were made, however, the Nuvalon costs were used as maximum.

In early March the Arthur D. Little Corporation had not been granted all of their patents, but were expecting them. On the basis of information and patents in hand, they estimated a $61.77 cost per ton of alumina by their process. Because of a patent pending they did not give us at that time any breakdown of the cost per ton of alumina. Neither were they in position to release projections of pilot construction and operation costs.

In February 1973, Arthur D. Little and Company, Inc. gave us a new best estimate, which included current costs and all their patents, of $58.46 per ton of alumina. They also furnished us on a non-disclosure basis an itemized summary of costs. This included current fuel and other operating costs, as well as reduced construction cost. Their figures are from non-integrated piloting of segments of the process. The segmented piloting ranged from bench-scale to much larger units and produced 300-400 pounds of alumina.

During the Fall of 1972 we requested both Arthur D. Little and another research corporation to give us construction and operation costs for a five tons per day of alumina pilot plant, in Georgia, using the ADL processes over a 3-5 year period. Both estimated essentially the same costs for a five year total of approximately $6.5 million -- provided government money and supervision were not involved. Both were of the opinion that five years would not be required. Piloting at a five tons of Al_2O_3 per day level has been estimated at $3-4 million for a period of time sufficient to test the process and give data for a larger installation.

If government money and supervision were to be involved, a 50 percent additional cost factor is suggested as being required to cover time delays required by federal regulations and procedures.

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA 30332

October 30, 1972

Georgia Department of Industry and Trade
Trinity-Washington Building
P. O. Box 38097
Atlanta, Georgia 30334

Attention: Colonel Harold A. Dye

Subject: Progress report on Industrial Development Research Project No. A-1458 "Implementation of Alumina from Kaolin Potentials"

Gentlemen:

In accordance with Paragraph 7 of Project No. A-1458 Agreement, the following quarterly progress report is submitted.

For the record, the following has occurred to date and is reported in somewhat of a diary format:

31 July, 1972 - John Husted met with an official of the United States Department of the Interior to discuss the report and make arrangements for a formal briefing on 9 August, 1972. Present at the meeting were John B. Rigg, Deputy Assistant Secretary-Minerals, Shelton P. Wimpfen, Assistant Director-Minerals, Bureau of Mines, and Ralph Kirby, Official Metallurgy, Bureau of Mines.

John Husted also contacted the Washington, D. C. office of Anaconda to give them the current status of our project. Anaconda is interested in the findings and recommendations of our report.

8 August, 1972 - John Husted visited Alcoa in Pittsburgh, Pennsylvania to discuss the report. Alcoa is pushing Anorthosite, but is very interested in the findings and recommendations of our report.

9 August, 1972 - General Truman and John Husted met with Senator Talmadge and two of his assistants, Daniel Mincheu and John B. Hayes, to discuss the project. Senator Talmadge offered his support in the implementation of the project. John Hayes requested information to be used in a cost-benefit analysis. This information has been furnished to you for forwarding to John Hayes.

General Truman, Harold Dye, John Husted, and Bill Ward met with John B. Rigg, Carl Rampacek, and Shelton Wimpfen of the United States Department of the Interior. A formal briefing of the project was given by Harold Dye, which was well received with many compliments from those present. The Department of the Interior's representative stated that they agreed with the findings in the report and would assist in any way they could toward implementation. Carl Rampacek was designated as our contact in the department.

Martin-Marietta group had read the report. At that time, prior to reading the report, Dr. Gamson and members of his staff were somewhat skeptical.

The Georgia Department of Industry and Trade put out a press release announcing a press briefing to be held on September 15, 1972. As a result of this release comprehensive news articles appeared in the "Macon Telegraph," "Atlanta Constitution," "Atlanta Journal," "Jefferson Reporter," and other newspapers in the state.

14 September, 1972 - John Husted met with John J. Miller, Technical Director, AMAX Aluminum Pacific Corporation and Frank Joklik, General Manager, AMAX Bauxite Corporation. Mr. Miller stated that AMAX was one of the smaller companies in the aluminum industry and that any industry participation would probably have to be lead by one of the three major producers, whom he named as Alcoa, Kaiser and Reynolds. Mr. Miller stated that AMAX would be interested in participation in a pilot plant on an industry basis with other companies. He recommended working through the Aluminum Association.

John Husted also met with D. J. Donaldson, Technical Manager of Raw Materials, Kaiser Aluminum and Chemical Corporation. Mr. Donaldson stated that it was his personal opinion that working through the Aluminum Association could be supported by his company and would be the favored means of assisting with a pilot plant in terms of any contribution that Kaiser would make.

22 September, 1972 - Harold Dye briefed the Mayor and members of the City Council and other officials in Macon, Georgia. Two news articles concerning the project and briefing appeared in the "Macon Telegraph."

25 September, 1972 - Harold Dye accompanied by Bill Ward briefed industrial leaders, members of the General Assembly, and other officials in Sandersville. This briefing also received extensive news coverage.

3 October, 1972 - John Husted met with Carl Rampacek, Assistant Director, U. S. Bureau of Mines, to discuss what had been done to date. Mr. Rampacek had forwarded a copy of the report to Peter Flanagan's office at the White House and had discussed the report with Mr. Gary Cook, Acting Director, Bureau of Domestic Commerce, Department of Commerce.

4 October, 1972 - John Hayes, Senator Talmadge's office, arranged three appointments for Harold Dye, John Husted, and Bill Ward to discuss the project. We met first with Mr. Richard Erb, Staff Assistant to the President, and Mr. David Gunning, assistant to Mr. Erb. Harold Dye briefed the group and general discussion took place. Mr. Erb and Mr. Gunning were very receptive and made several suggestions. One was to get definite industry reaction as to what industry will do and what problems existed that can only be met at the Federal level.

We next met with Mr. Gary Cook, Acting Director, Bureau of Domestic Commerce, Department of Commerce, and members of his staff including Kenneth G. Conner, Director, Office of Business Research and Analysis. This group was also very receptive and after Harold Dye's briefing the discussion centered on the effect of such a project on domestic commerce and possible sources of funding. Mr. Cook supported the project and asked his staff to keep aware of developments.

Our next appointment was with Mr. Jack Bennett, Deputy Under Secretary for Monetary Affairs, Department of the Treasury, and a member of his staff. Again Harold Dye gave a briefing which was extremely well received. Mr. Bennett is originally from Macon and is familar with Georgia kaolin. In the discussion, the balance of trade situation and sources of funding were the major topics. Mr. Bennett said he would discuss the project with the top people in the Department of the Treasury. He further stated that we could use his name in any further discussions within the Department.

9 October, 1972 - John Husted met with officials of Anaconda Aluminum Company to discuss the project. Present were Joseph B. Woodlif, President; John B. Sanderlin, Senior Vice-President, Finance and Administration; Donald W. Everett, Group Vice-President, Primary Operations; and Robert E. Sullivan, Alumina Manager. The major outcome of the discussion seems to be that Anaconda is interested in meeting with other aluminum companies to discuss means of implementing a pilot plant directed toward using kaolin for alumina.

12 October, 1972 - The second in the series of briefings for industrial leaders, members of the General Assembly, and other officials was held in Warner-Robins. Harold Dye accompanied by John Husted conducted the briefing. Again the briefing was well received and was given extensive news coverage.

13 October, 1972 - Harold Dye and John Husted met with officials of National-Southwire Company to discuss the project and future actions. This was a most fruitful meeting with many good suggestions made.

18 October, 1972 - The third briefing for industrial leaders, members of the General Assembly, and other officials was held in Americus. Harold Dye conducted the briefing with the same enthusiastic response as from the previous briefings.

As a result of many discussions and conferences it appears that the project has been well received by all and is supported by most. There are some reservations in some minds. There is a question as to the total dollars required for construction and three year operation of a pilot plant. It may be that our current figure is somewhat high. In light of this, new estimates of cost are being secured.

In so far as immediate future plans are concerned, it is our intention during the next quarter to develop minimum cost figures, meet with industry leaders to determine what they will do, and what is needed from government, both Federal and State. Subsequent to this determination, a concerted effort will be made to secure funding for the project from sources identified.

If there are any questions or additional information is desired, please give me a call.

Sincerely,

William C. Ward, Jr.
Head, Industrial Services Branch

WCW/seb

cc: Mr. Ross Hammond
Dr. John E. Husted
ORA (2)
File A-1458

ORA

ENGINEERING EXPERIMENT STATION

GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

2 February 1973

Georgia Department of Community Development
Trinity-Washington Building
P. O. Box 38097
Atlanta, Georgia 30334

Attention: Colonel Harold A. Dye

Subject: Quarterly Progress Report (No. 2) on Industrial Development Research Project No. A-1458 "Implementation of Alumina from Kaolin Potentials" Period November 1, 1972 - January 31, 1973

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following quarterly progress report is submitted.

The keynote of the second quarter of this project is the increased interest in alumina from kaolin. This has been manifested by visits from two companies from foreign countries, as well as visits from and appointments made for visits by domestic companies.

Events will be listed essentially in chronological order.

1. A visit was made to Reynolds Aluminum Company in Richmond, Virginia by John E. Husted on October 24, 1972, but his visit was on a continuing trip to the Rocky Mountain area and he did not return in time for the results of his visit to be reported in the first quarterly report. Points made by Reynolds concerning our "Alumina from Kaolin Potentials" are as follows:

   a. Overall, they thought the report was good.
   b. They expressed considerable skepticism concerning our process costs.
   c. They thought the federal government <u>should</u> evaluate the program and put the pilot plant out for bid for operation by <u>one</u> company according to a specific contract. They thought the coal gassification project in West Virginia could serve as a guide.
   d. They were of the opinion that the two major problems to be attacked in a pilot plant were ways of reducing energy consumption and the use of equipment materials that would have a long replacement time in order to lower maintenance costs.
   e. They thought <u>our</u> first and major problem was to secure funding for a pilot plant.
   f. We were urged to continue our political efforts to secure such funding.

2. Visit with Frank Stephens, Vice President, Heazen Research, Golden, Colorado, October 25, 1972.

Mr. Stephens gave the following cost estimates, if his company did the work, concerning a pilot plant, located in Georgia, using kaolin to produce five tons per day of alumina by the Arthur D. Little process. The costs were estimated on a July 1, 1973 starting date:

a. To build the plant, he estimated $500,000 to $600,000.
b. The operation of the plant was estimated at roughly $1,000,000 per year.
c. For construction and five years of operation he estimated $6,000,000 -- without government funding or supervision. He stated a fifty percent add on was necessary for government contracts to take care of the extra time and red tape involved in governmental supervision and decision making.

3. On December 12, 1972, a meeting was held in Atlanta with representatives of Noranda Manufacturing Limited, of Toronto, Ontario, Canada, National-Southwire Aluminum Company, the Georgia Department of Community Development, and the Engineering Experiment Station at the Georgia Institute of Technology.

The meeting resulted in a great show of interest in use of Georgia's kaolin for alumina, but also revealed some unanswered questions.

A letter to Colonel Harold A. Dye from Noranda on January 2, 1973, spelled out their unanswered questions in eight areas. While some of the information is available, an effort is being made to secure the remaining information required to respond to Noranda in full.

4. On December 14, 1972, an "Update" of cost information in the "Alumina from Kaolin Potentials" report was made available.

5. In December a form letter was prepared for distribution to the kaolin companies. The purpose of the letter was to request any company holding large kaolin reserves to indicate their willingness to be contacted by companies seeking kaolin for alumina production. The letter was prepared for distribution by the Georgia Department of Community Development.

6. The November 1972 issue, page 25, of Engineering and Mining Journal (McGraw-Hill), which was received in December, carried a summary of the "Alumina from Kaolin Potentials" report.

7. The January 20, 1973 issue of Business Week (McGraw-Hill), page 92, carried an article on "A revolutionary Alcoa process for producing alumina." The furnace feed material is an anhydrous aluminum chloride produced by chlorination of alumina prepared by the Bayer process.

Observations pertinent to Georgia's kaolin are:

a. Although Bayer process alumina is mentioned in the article, any alumina of sufficient purity should be suitable for chlorination for use by the

Alcoa process. This probably enhances the possible use of Georgia's kaolin for producing alumina.

b. The major and probable prohibitive reason that aluminum chloride from a hydrochloric acid leach of kaolin could not be used directly is the requirement for an anhydrous aluminum chloride. The vaporization-sublimation temperatures of water and aluminum chloride are too over-lapping for thermal separation plus the strong tendency for aluminum chloride to hydrolize or to produce a hydrous oxide composition.

c. The reduced power requirements for Alcoa's $Al\ Cl_3$ process possibly would permit metal production in Georgia and a subsequent integrated aluminum industry.

8. A meeting was held in Atlanta on January 30, 1973, with representatives of Pechiney Ugine Kuhlman, Georgia Department of Community Development, and Engineering Experiment Station, at the Georgia Institute of Technology.

Representatives from Pechiney included the president of their American subsidiary (Robert Agenet), Program Director of Extractive Metallurgy (Jacques Coursier), the Director of their Barasse factory in Marseille, France, (Jean Maury), and a mining engineer and former American representative (Jean Michelet). Mr. Michelet also had attended the September 1970, alumina conference held here in Atlanta.

The meeting, from time of arrival until their 4:30 p.m. return to their hotel, was friendly, consentrated, and mentally and verbally vigorous. Language was no problem.

The meeting was an in-depth probing of various parts of our "Alumina from Kaolin Potentials" report. William C. Ward, Jr. and John E. Husted of the Engineering Experiment Station are of the opinion that the visitors obtained the information they came for and were satisfied with the meeting. In fact they so indicated. It is not believed that they will independently finance a pilot plant at this time.

9. A meeting is scheduled at the Engineering Experiment Station at the Georgia Institute of Technology, Tuesday, February 6, 1973, with representatives of Arthur D. Little, Inc., National-Southwire Aluminum Company, Georgia Department of Community Development, and the Engineering Experiment Station team.

10. A meeting is scheduled March 6, 1973, with Anaconda Aluminum Company, the Georgia Department of Community Development and the Engineering Experiment Station at the Georgia Institute of Technology.

Mr. Bob Sullivan of Anaconda Aluminum visited John Husted on January 31, 1973, while at the Engineering Experiment Station on other business. He gave an off-the-cuff estimate of $3,500,000 for a five tons per day of alumina pilot plant -- one year operation. He stated that alumina prices varied over a <u>very wide range</u> and that Bayer-bauxite alumina costs and those of alumina from kaolin are closing together much faster than anyone would have guessed five years ago.

11. Senator Talmadge has kept us informed of his inquiries to OEP and other government agencies concerning the government's position and policy on this project. He has

stated that he will contact us when he has some answers to his inquiries.

12. Dr. Husted has been invited and has accepted the chairmanship of a session on industrial mineral sources of aluminum at the Pittsburgh (September 1973) meeting of the Society of Mining Engineers (SME) of the American Institute of Mining, Petroleum, and Metallurgical Engineers (AIME). It appears that one of the reasons for this invitation was the work done on this kaolin project. This chairmanship will allow Dr. Husted to address himself specifically to the work done concerning alumina from kaolin as compared to other materials.

13. William C. Ward, Jr. and John E. Husted are of the opinion that despite skepticism by industry of the estimated cost per ton of alumina by the Arthur D. Little process the following should be borne in mind.

a. Until a pilot plant can substantiate any projected costs, barring new technical breakthroughs, we are only playing games with numbers in adjusting the best estimate.
b. Since the start of our alumina from kaolin effort the price of bauxite has steadily climbed. Some of the climb is from inflation, but another substantial part is from "pay-offs", new taxes, etc., in foreign countries.
c. The increased interest in finding sources of aluminum from a wide variety of non-bauxite materials also increased the probability that one or more of these may become an ore of aluminum. With enormous reserves of kaolin in Georgia, the relatively high alumina content of kaolin, the amount of research to date, and relative closeness to reduction plants, it would appear that kaolin should be our first commercial non-bauxite source of alumina.

Sincerely,

William C. Ward, Jr.
Head, Industrial Services Branch

WCW:mk

cc: Mr. Ross W. Hammond
Dr. John E. Husted
ORA (2)
File A-1458

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

1 May 1973

Georgia Department of Community Development
Trinity-Washington Building
P. O. Box 38097
Atlanta, Georgia 30334

Attention: Colonel Harold A. Dye

Subject: Quarterly Progress Report (No. 3) on Industrial Development Research Project No. A-1458 "Implementation of Alumina from Kaolin Potentials" Period February 1, 1973 - April 30, 1973

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following quarterly progress report is submitted.

As was reported in the second quarterly report the keynote of the third quarter of this project is the continued increased interest in the potential of development of alumina from kaolin. This interest has been manifested by in-depth examination of such potentials by several companies. These companies are now more interested in exploring all alternate processes for the production of alumina from kaolin with particular emphasis on the comparison of costs by alternate processes at various levels of production.

Events will be listed essentially in chronological order.

1. On February 6, 1973, a meeting was held in Atlanta with representatives of Arthur D. Little, Inc., National-Southwire Aluminum Company, the Georgia Department of Community Development, and the Engineering Experiment Station at the Georgia Institute of Technology.

The meeting was a most fruitful meeting with a frank exchange of information and discussion of the Arthur D. Little, Inc. process. One objective of the meeting was to secure some of the information requested by Noranda Manufacturing, Limited as reported in our February 2, 1973 progress report.

Arthur D. Little, Inc. representatives furnished, on a non-disclosure basis, schematic flowsheet, material balance chart, detailed capital costs estimate, estimated off-site costs, cost of manufacturing, and major equipment list for a nitric acid low temperature plant producing 300,000 tons of alumina per year. The estimated cost of manufacture did not include financing costs and royalties expected by the Arthur D. Little, Inc. As a result of the discussions on the optimum size for a commercial size plant, Arthur D. Little, Inc. was requested to scale up their cost estimates to plants producing 600,000 and 900,000 tons of alumina per year to include financing cost and royalties. Arthur D. Little, Inc. agreed to do this.

As a result of the new cost estimates from Arthur D. Little, Inc., the research team prepared an update of costs, as of February 12, 1973, for manufacture per ton of alumina and for construction and operation for a five tons per day of alumina pilot plant. A copy of this update is attached to this report.

2. On February 8, 1973, Dr. John E. Husted visited the U. S. Department of the Interior, the U. S. Bureau of Mines, and Senator Herman E. Talmadge's office in Washington. The purpose of this visit was to maintain contact with those people in government who have been working with us in our efforts to secure funding for a pilot plant operation.

3. On February 9, 1973, Senator Talmadge forwarded us a copy of a letter from the Honorable Hollis Dole, Assistant Secretary of the Interior, in response to his inquiry of the Department regarding their position on the dependency on overseas supply of aluminum. Secretary Dole stated the Department's policy, with respect to aluminum, is to conduct investigations to develop additional domestic resources of aluminum and to encourage industry to develop alternate sources of aluminum raw materials. This position is the same as ours.

4. On February 14, 1973, Dr. John E. Husted in response to a request from Mr. William L. Shafer, Consultant, Committee on Interior and Insular Affairs, U. S. House of Representatives, forwarded a copy of the "Alumina from Kaolin Potentials" report. Dr. Husted informed Senator Talmadge's office of this request and his response.

5. On February 16, 1973, in response to a request from Senator Talmadge's office, an updated forecast of dollar deficits due to aluminum source imports was made and forwarded to his office. This new additional dollar out-flow forecast was made necessary because of the recent dollar devaluation which increased our forecast of deficit balance of payments.

6. On February 22, 1973, Senator Talmadge forwarded us a copy of a letter from the Office of Emergency Preparedness on their current position on the importation of alumina. This letter enclosed an OEP staff paper on this subject. The letter indicated a very narrow point of view from a national security standpoint based on an assumption in the staff paper that all present Free World sources of bauxite and alumina would be accessible to the U. S. in an emergency period. In view of past experiences, I question the validity of this assumption. The staff paper pointed out that the principal domestic source of bauxite is in Arkansas and highlighted the fact that the Arkansas production was developed under a World War II expansion program. The same requirement could again occur.

7. On March 6, 1973, a meeting was held in Atlanta with representatives of Anaconda Aluminum Company, National-Southwire Aluminum Company, the Georgia Department of Community Development, and the Engineering Experiment Station, Georgia Institute of Technology. The Anaconda representatives were the President, Vice President and General Manager, Group Vice President-Primary Operations, and Alumina Manager.

The basic reason for Anaconda's visit was to seek assistance in obtaining an unbiased comparative evaluation between Anaconda's hydrochloric acid alumina from kaolin process and Arthur D. Little's nitric acid alumina from kaolin process, or any other non-bauxite competitive process. To this end they are willing to give full information on their process on a non-disclosure basis. Anaconda requested Dr. Husted to make an initial evaluation of their hydrochloric acid process. The Anaconda Aluminum Company furnished Dr. Husted with an internal report of theirs that summarized information on their hydrochloric acid process, including projected costs. The thrust of the report was that although the projected cost of the Anaconda process is higher than the Arthur D. Little, Inc. projected costs, the Anaconda process is based on 5 to 7 tons per day integrated pilot plant operation, whereas the Arthur D. Little, Inc. process has not been piloted in an integrated pilot plant. Dr. Husted concurs with the Anaconda opinion that until the Arthur D. Little, Inc. process has been piloted in like manner, the cost differences are not sufficient to select one process over the other.

The Anaconda pilot plant in Montana is still essentially intact. We were invited to visit the pilot plant to see the size and equipment there.

In addition the Anaconda Aluminum Company expressed its willingness to participate with anyone and will submit all information on its process for full evaluation.

It was decided that full technical evaluations are desirable. Estimated cost of full technical evaluation of various processes from non-bauxite alumina was $200,000 maximum. The favored agency to conduct such an evaluation is the U. S. Bureau of Mines.

As a follow-up to the March 6, 1973 meeting, the President of Anaconda Aluminum Company, was on March 20, 1973, requested to write the Secretary of the Interior offering to provide all of its information if the U. S. Bureau of Mines will make a comparative evaluation of various processes from non-bauxite alumina. He agreed to do this and stated such an offer would be made upon return of a key individual from an overseas trip. To date we have no information that this has been accomplished.

8. On March 20, 1973 as a follow-up to our February 6, 1973 meeting with Arthur D. Little, Inc., we recontacted Richard W. Hyde of Arthur D. Little, Inc., to determine the status of the cost estimates for plants producing 600,000 and 900,000 tons of alumina per year. Due to other internal problems the cost estimates had not been completed but would be completed as soon as possible.

9. On March 28, 1973, Dr. John E. Husted met with Carl Rampacek, Assistant Director, U. S. Bureau of Mines, Metallurgy. Mr. Rampacek indicated that his division is considering proposing, internally within the Bureau of Mines, a three-year project to evaluate domestic non-bauxite sources of aluminum. Their proposal would call for a mini-pilot plant to operate over a period of three years at a budget of $300,000 to $400,000 per year. The plant capacity is estimated at roughly 25 pounds per hour, eight hours per day for a daily capacity of approximately 200 pounds of alumina.

Currently, minimum plans are to test clay (kaolin) by acid process, alunite, and anorthosite raw materials in this mini-pilot plant.

Since this proposal is still under consideration, starting dates and other detailed information will have to be determined at a later date.

The information relative to U. S. Bureau of Mines internal plans was passed on to Mr. Bob Sullivan, Alumina Manager, Anaconda Aluminum Company on March 29, 1973.

10. On April 6, 1973, a meeting was held in Atlanta with representatives of Ledgemont Laboratory of Kennecott Copper Corporation, Georgia Department of Community Development and the research team. Mr. H. William Flood, Manager, Process Engineering and Evaluation for the Ledgemont Laboratory of Kennecott Copper Corporation was very familiar with our report and desired to discuss the status of our project. He was interested in what the state of Georgia would and could do to support such a project. He was informed that a resolution had been introduced into the General Assembly to pay $250,000 to the company that establishes the first commercial alumina plant using Georgia kaolin. He also was informed of the normal assistance given to companies planning to locate a plant in Georgia.

The major reason for interest in alumina from kaolin is that Kennecott has a pilot plant facility at the Ledgemont Laboratory capable of testing alumina from kaolin. The Laboratory is seeking possible major projects to be started by the Laboratory in the near future. This would be done under the company's research and development program utilizing internal funds. All of their questions were answered and indications were that they would be back in touch with us as to their decision on whether or not to proceed with this project.

11. There is evidence that there is continuing and increasing interest by industry in non-bauxite sources of aluminum raw materials. In the March 7, 1973 issue of Chemical Week there appeared another article on Georgia's efforts to secure funding for an alumina from kaolin project which keeps the issue before industry.

12. The present position of the project seems to be in a holding pattern between major decisions. We have had strong indications of interest from at least three domestic and three foreign companies. We are aware that detailed economic analyses are being made by several of these companies as well as both internal and external research efforts. As the research team can only observe that proprietary information released to them, the conclusion may be reached that there could be considerably more activity than the team has been privy to. While at present there are no announcements of positive plans to utilize Georgia's clay for alumina, in-depth investigation is being made by companies prior to making firm decisions to proceed.

The U. S. Bureau of Mines appears to be in a similar position, in that although there is no particular observable activity, there are plans for requesting budget for a mini-pilot plant to test various sources of aluminum.

There is evidence that other federal agencies are aware of the alumina from kaolin potentials and that they are looking closely at the project. This is based on the fact that when other non-bauxite sources are advocated these agencies also indicate the need to consider kaolin along with the consideration of other non-bauxite material.

13. The plans and objective of the research team for the remaining quarter of the project is to continue to work with industry to assist them in arriving at a positive decision to enter into alumina production from Georgia's kaolin.

The coming months could be crucial. The meetings of companies' boards for the determination of the next calendar year's budget are usually held in the fall. Preparations for presentations to the boards concerning capital expenditures for research and development, or new construction are in progress now.

The research team also plans to work with governmental agencies to determine what can and will be done and hopefully to influence such decisions.

Sincerely,

William C. Ward, Jr.
Head, Industrial Services Branch

WCW:mk

cc: Mr. Ross W. Hammond
Dr. John E. Husted
ORA (2)
File A-1458

A-1458

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

1 August 1973

Georgia Department of Community Development
Trinity-Washington Building
P. O. Box 38097
Atlanta, Georgia 30334

Attention: Mr. Michael H. Lott

Subject: Quarterly Progress Report (No. 4) on Industrial Development Research Project No. A-1458 "Implementation of Alumina from Kaolin Potentials" Period May 1, 1973 - July 31, 1973

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following quarterly progress report is submitted.

As was reported in the third quarterly report the keynote of the fourth quarter of this project was the focusing of the continued interest of both industry and governmental agencies on specific actions required to implement the potential development of producing alumina from kaolin. This focusing of interest has been manifested by the response of several kaolin companies indicating that they have available large kaolin reserves and are extremely interested in the alumina from kaolin potential. In addition detailed cost information is being requested and evaluated by interested companies in the aluminum industry. Further, the U. S. Bureau of Mines has plans for mini-pilot plant operations using Georgia kaolin. Each of these items will be discussed in more detail in this report.

Major events are as follows:

In response to an inquiry from the Georgia Department of Community Development, requesting information as to the availability of at least 150 million tons of kaolin for the production of alumina the following companies stated that they had reserves of this magnitude and were extremely interested in discussing the possibility of disposing of these reserves.

Anglo-American Clays Corporation
Sandersville, Georgia

Georgia Kaolin Company
Elizabeth, New Jersey

Thiele Kaolin Company
Sandersville, Georgia

Horton International, Inc.
Sandersville, Georgia

This information was requested from the kaolin companies so that we could respond to questions presented by an aluminum company who is interested in developing a source of alumina from non-bauxite ore.

As a result of the February 6, 1973 meeting with representatives of Arthur D. Little, Inc., National-Southwire Aluminum Company, the Georgia Department of Community Development, and the Engineering Experiment Station at the Georgia Institute of Technology, which was reported in the third quarterly report, additional information was furnished by Arthur D. Little, Inc.

Arthur D. Little, Inc. reviewed in detail the flow sheets and material balances and updated the capital and operating costs for the Arthur D. Little, Inc. Alumina Process. As agreed at the February meeting, Arthur D. Little, Inc. brought the estimates up to present-day costs for the 300,000 tons per year (TPY) size and 900,000 TPY size. This was accomplished on a step-by-step analysis of all major equipment items including examination of unit sizes that are practical to consider. The revised capital costs were made on the latest modification of the process. The operating cost estimates for the operation at 300,000 and 900,000 TPY are based upon the unit costs applicable to an installation in Georgia. The revised capital costs for 300,000 TPY and 900,000 TPY are $48,296,000 and $105,636,000 respectively. The revised cost of manufacture for 300,000 TPY and 900,000 TPY are $61.71 per ton of alumina and $52.52 per ton of alumina respectively. The operating costs are based upon a 100% equity, thus, these operating costs do not include debt service, i.e., interest and loan repayments. It is considered that even with debt service costs added that total cost will not exceed $70 per ton of alumina which is competitive in today's market.

The above information has been furnished to two interested companies in the aluminum industry and indications are that some decisions as to the next steps to be taken will be forthcoming in the next three to four months.

Effective July 1, 1973 the U. S. Bureau of Mines (Department of the Interior) was funded for and authorized to proceed with a mini-pilot plant operation at Boulder City, Nevada. The pilot plant work will be directed toward obtaining technical and cost information for obtaining alumina from clay. The designation "mini" refers to the size of the plant whose capacity will be in pounds per hour. The plant will be fully integrated and to scale. This procedure will be to make engineering estimates of the process, design and construct a mini plant based on these engineering estimates, operate the plant on a continuous basis to obtain cost and technical data for process evaluation, and repeat procedure on other processes, using two or more teams, so that one team can be operating on one process and system while an additional team designs another system for some other process. The U. S. Bureau of

Mines has obtained 30 tons of Georgia kaolin for its initial work and it is reported that its first effort will be a nitric acid process similar to the Arthur D. Little alumina process. The Bureau has invited industry to enter into cooperative agreements for this or other alumina processes on a single or multiple basis. Under such agreements several mini-pilot plants could run concurrently.

These small plants, while not as effective as larger pilot plants for scaling up to commercial size plants, should permit realistic comparisons of technology and costs as they all will be at the same scale. The results of the project are eagerly awaited. A visit to the site by the research team may be made in the near future. Results of this effort are badly needed. While several aluminum companies have continued to show interest in alumina from kaolin, the current attitude is to wait on the U. S. Bureau of Mines results before making firm commitments to proceed. It is known, however, that the Arthur D. Little Corporation has non-disclosure agreements with companies interested in their process. Results of evaluations resulting from disclosure are not known at this time.

Dr. John E. Husted in a report, to the U. S. Bureau of Mines, concerning potential domestic sources of alumina stated that alumina from kaolin commercial production should be on-stream by 1982 if piloting proves that it is economically feasible and further that he expected kaolin from Georgia to be the first major non-bauxite source of alumina.

Alunite may be the first domestic non-bauxite source of alumina, but reserves of alunite are not known to be of the same order of magnitude as kaolin. The geographic location of alunite is also a disadvantage. Hence, it is not thought that alumina from alunite should have a negative effect on alumina from Georgia kaolin.

An added incentive to the establishment of an alumina from Georgia kaolin industry is the recently announced Alcoa process of producing aluminum at reduced power requirement. The process to be used is claimed to reduce by as much as 30% the electricity required by the most efficient units of the traditional Hall process which is used worldwide. With such a smelting process for aluminum available the next logical step from alumina from Georgia kaolin would be aluminum from Georgia alumina. From this could come extrusion plants and fabrication plants.

The continuing and increasing interest by industry in non-bauxite sources of aluminum raw materials is evidenced by another article on Georgia's efforts to secure funding for an alumina from kaolin project in the April 1973 issue of Engineering/Mining Journal. An article in the July 1973 issue of Engineering/Mining Journal commented on the proposed alumina from alunite pilot plant. Such articles keeps the issue before the industry on a continuing basis.

The plans and objective of the research team in the coming quarter is to continue to work with industry to assist them in arriving at a positive decision to enter into alumina production from Georgia's kaolin. The research team also plans to work with governmental agencies to determine what results are obtained from mini-pilot plant operations and what can and will be done with these results to hopefully influence such decisions.

To this end Dr. John E. Husted is expected to visit with the U. S. Bureau of Mines and other interested persons in Washington, D. C. in early August to determine current status and future plans of the Federal Government. Depending on the results of this discussion a visit to the mini-pilot plant site by the research team may be made in the near future. The research team has been invited to visit the Anaconda alumina plant in Butler, Montana. This is the plant that produced alumina from Georgia kaolin several years ago.

Sincerely,

William C. Ward, Jr.
Head, Industrial Services Branch

WCW:msk

cc: Mr. Ross W. Hammond
Dr. John E. Husted
ORA (2)
File A-1458

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

1 November 1973

Georgia Department of Community Development
Trinity-Washington Building
P. O. Box 38097
Atlanta, Georgia 30334

Attention: Mr. Michael H. Lott

Subject: Quarterly Progress Report (No. 5) on Industrial Development Research Project No. A-1458 "Implementation of Alumina from Kaolin Potentials" Period August 1, 1973 - October 31, 1973

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following quarterly progress report is submitted.

As was reported in the fourth quarterly report, the keynote of the fifth quarter of this project was the continued interest of both industry and governmental agencies on specific actions required to implement the potential development of producing alumina from kaolin. This interest has been manifested by requests for information from companies in the aluminum industry as well as from additional governmental agencies. In addition, verification of the availability of kaolin reserves and their location has been requested by companies evaluating the feasibility of alumina from kaolin. Increased interest in the U. S. Bureau of Mines mini-pilot plant operations by industry and other governmental agencies, both foreign and domestic, is evident.

Major events are as follows:

Frequent personal contacts have been made throughout the quarter with Carl Rampacek, Assistant Director, U. S. Bureau of Mines, Metallurgy, and Ralph Kirby and Kenneth Higbie, U. S. Bureau of Mines. As was reported last quarter, the U. S. Bureau of Mines was funded for and authorized to proceed with a mini-pilot plant operation at Boulder City, Nevada using Georgia kaolin for the production of alumina. The U. S. Bureau of Mines has 30 tons of Georgia kaolin on site in

Boulder City for its initial work. Since the joint meeting in Washington, D. C. in July 1971, of Government and aluminum industry representatives, there has been a continuing interest by some aluminum-producing companies in an alumina pilot plant research program similar to the one the U. S. Bureau of Mines has underway. The pilot plant work is directed toward obtaining technical and cost information for the production of alumina from clay. New improvements and approaches developed by industry and the Government for recovering alumina from clay will be tested and evaluated in the plant. The pilot plant is fully integrated and to scale. Engineering estimates of the process have been made. The plant has been designed and constructed. All equipment has been ordered and most of the equipment has been received and installed. There has been a longer lead time, than anticipated, required on some pieces of equipment, but all equipment should be received and installed by mid November 1973. Two of the stages, of the process, have been completed and are in operation. With the major installations completed in November 1973 and completely integrated operations underway, some preliminary conclusions may be drawn by February or March 1974. Final conclusions on the nitric acid process should be available after a few months of continuous operation.

The U. S. Bureau of Mines has informed us that they have been contacted by several aluminum companies requesting detailed information about the pilot plant and plans for research on producing alumina from non-bauxite sources. They further stated that interest in what is being done has been expressed by almost all aluminum companies. As a result of this interest, the U. S. Bureau of Mines will publish preliminary progress reports during the research, as well as a final report upon completion of the nitric acid process testing. Additional processes, using clay, will be tested upon completion of the nitric acid process.

Arthur D. Little, Inc., (ADL, Inc.) as a result of its detailed review of its process, furnished a corrected flow sheet that applies to the capital and operating costs previously submitted. The capital costs for 300,000 tons per year (TPY) size and 900,000 TPY are $48,296,000 and $105,636,000 respectively. The cost of manufacture for 300,000 TPY and 900,000 TPY are $61.71 per ton of alumina and $52.52 per ton of alumina respectively. These operating costs do not include debt service which will increase the total cost to approximately $70 per ton of alumina.

Considerable interest has been shown in the ADL, Inc. nitric acid process by various aluminum companies. ADL, Inc. has signed non-disclosure agreements with two aluminum companies who have analyzed the process in detail. One aluminum company has authorized ADL, Inc. to indicate its willingness to work with any other company in exploring the possibility of producing alumina from kaolin. ADL, Inc. informed another aluminum company of the willingness of this company to work with them. The reaction of the second company was one of extreme interest and an indication that the two companies will get together and discuss the possibility of a cooperative effort. This will be monitored by the research team.

As a result of a third company's interest in the production of alumina from kaolin, ADL, Inc. requested verification of the availability of kaolin reserves for the production of alumina. This verification was furnished to ADL, Inc. based upon letters received from kaolin companies stating the availability of kaolin in the quantity and quality desired.

Dr. John E. Husted was requested to meet with representatives of an aluminum company that is extremely interested in exploring the use of non-bauxite materials for alumina. This is one of the companies that has signed a non-disclosure agreement with ADL, Inc. The company revisited ADL, Inc. for the purpose of discussing in detail the ADL, Inc. nitric acid process. The company has expended a considerable amount of effort at the highest corporate level in evaluating information on several processes and materials. This company has proceeded to the point currently of evaluating specific elements of a process to produce alumina from kaolin. Information has been requested, from the research team, as to the availability and cost of fuel (gas, oil, coal) and availability of process water in the kaolin belt of Georgia. The information requested is based on a projected alumina from kaolin plant of from 300,000 to 500,000 tons per year of alumina, with possible expansion to 1,000,000 tons per year of alumina. The information needed is being compiled and will be furnished to the company. The company indicated that after receipt of the requested information, it would recontact us for further detailed discussions.

Dr. John E. Husted was chairman of a session on industrial mineral sources of aluminum at the Pittsburg, Pa. (September 1973) meeting of the Society of Mining Engineers (SME) of the American Institute of Mining, Petroleum, and Metallurgical Engineers (AIME). This chairmanship allowed Dr. Husted to address himself specifically to the work done concerning alumina from kaolin, as compared to other materials. At this meeting, Dr. Husted was approached by Peter T. Frawley, Commercial Counsellor, Australian Embassy and Henry C. Armstrong, Commercial Counsellor, Canadian Embassy, expressing interest in the alumina from kaolin project. Mr. Armstrong stated that the Aluminum Company of Canada (ALCAN) should be interested in the project. Mr. Dave

Robertson, ALCAN representative in Atlanta, Georgia, contacted the research team and stated that certain members of his company desired to visit the kaolin belt of Georgia and would be back in touch with us to arrange a visit.

At this same meeting, Mr. Donald F. Meyers, Division of Industrial and Strategic Materials, U. S. Department of State and Mr. James M. Owens, Director, Minerals Division, Bureau of Domestic Commerce, U. S. Department of Commerce, requested that the research team meet with them to discuss the alumina from kaolin project. The research team visited Mr. Meyers and Mr. Owens as requested. These gentlemen are interested in exploring the need for an economic stockpile of industrial materials as distinguished from a strategic stockpile. Domestic sources of aluminum materials is one they are considering. They both support the alumina from kaolin project and are monitoring the efforts of the U. S. Bureau of Mines pilot plant project. Due to a current shortage of aluminum metal and a policy decision, aluminum is being made available to industry from the strategic stockpile. We were informed that several aluminum companies had been to Washington to request part of the aluminum metal being released from stockpile.

The continuing and increasing interest by industry in non-bauxite sources of aluminum raw materials is evidenced by two articles on extracting aluminum from clay appearing in the August 1973 issue of Engineering/Mining Journal and the August 9, 1973 issue of New Scientist. Such articles keep the issue before the industry on a continuing basis.

Burlington Northern Railroad Company is preparing a booklet on Domestic Aluminum Sources and has asked Dr. John E. Husted to comment on it before publication. This booklet will include the potential of kaolin as an aluminum source. Dr. Husted's comments will insure Georgia's kaolin being presented in a factual and favorable light. In addition, the current research being done by the U. S. Bureau of Mines utilizing Georgia kaolin will be covered.

The plans and objective of the research team in the coming quarter is to continue to work with industry to assist them in arriving at a positive decision to enter into alumina production from Georgia's kaolin. The specific information requested by an aluminum company will be provided and additional information furnished as the decision process continues. The research team also plans to continue work with governmental agencies to determine what additional efforts will be forth coming from the government. Specifically, we shall work with the U. S. Bureau of Mines to determine what results are obtained from the mini-pilot plant operations and what can and will be done with these results to hopefully influence favorable decisions by industry.

To this end, Dr. John E. Husted visited the Anaconda alumina plant in Butte, Montana the last week in October 1973. This is the plant that produced alumina from Georgia kaolin several years ago. Aluminum metal was also produced from this alumina. The U. S. Bureau of Mines has invited the research team to visit the mini-pilot plant site when the plant is in full and continuous production. Such a visit by the research team may be made during the next quarter.

Sincerely,

William C. Ward, Jr.
Head, Industrial Services Branch

WCW:lgh

cc: Mr. Ross W. Hammond
Dr. John E. Husted
Mr. William C. Hawthorne (10)
ORA (2)
File A-1458

A-1458

ENGINEERING EXPERIMENT STATION

GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

February 1, 1974

Georgia Department of Community Development
Trinity-Washington Building
Post Office Box 38097
Atlanta, Georgia 30334

Attention: Mr. Michael H. Lott

Subject: Quarterly Progress Report (No. 6) on Industrial Development Research Project No. A-1458 "Implementation of Alumina from Kaolin Potentials" Period November 1, 1970 - January 31, 1974

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following quarterly progress report is submitted.

The keynote of the sixth quarter of this project was the continued and increased interest of both industry and governmental agencies on specific actions required to implement the potential development of producing alumina from non-bauxite sources. This interest has been manifested by an increasing awareness of the United States' vulnerability in the minerals field due to the nation's dependence on foreign sources of raw materials. This concern has been centered among middle-echelon government employees, private economists and industry executives, but it is starting to spread to the ranks of government policymakers. Interior Secretary Rogers Morton suggests that unless protective steps are taken, the United States could face a minerals crisis and a materials crisis. He stated that there is "no reason why the group of countries that supply most of our bauxite can't get together the way oil-producing countries got together on the price of oil." In addition, continued interest in the U. S. Bureau of Mines mini-pilot plant operations by industry and other governmental agencies is increasing and becoming more evident.

Major events are as follows:

Frequent personal contacts have been made throughout the quarter with Carl Rampacek, Assistant Director, Metallurgy, U. S. Bureau of Mines and others to remain current on the progress of the mini-pilot plant operations at Boulder City, Nevada, using Georgia kaolin for the production of alumina.

The Assistant Director, U. S. Bureau of Mines, Mr. John D. Morgan, Jr., has distributed to individual firms in the domestic aluminum industry copies of the U. S. Bureau of Mines program, "Alumina from Domestic Resources, a

Miniplant Project to Evaluate Alumina Recovery Processes." This program was forwarded to Dr. John E. Husted, a member of the research team, by the attached letter dated January 21, 1974.

The program is summarized by the U. S. Bureau of Mines as follows:

"The challenge to develop an economic method for recovering alumina from domestic resources is a typical example of an opportunity to solve an increasingly unfavorable mineral supply problem. The U. S. produces about 34% of the world's aluminum, yet must import 90% of the raw materials needed. There are abundant domestic resources of aluminum-bearing minerals such as clay, anorthosite, alunite, shale, and dawsonite, but none of the numerous processes proposed for recovering alumina from them has yet proved economically competitive with the Bayer process using imported bauxite. World supplies of bauxite are adequate, but the U. S. must increasingly compete for them with other industrialized countries also seeking reliable sources of these raw materials at an acceptable price. Nationalization of bauxite mining operations in some of the producing countries and unstable political climates add to the uncertainty of U. S. supplies and threaten to substantially increase the cost of bauxite to the nation at any time.

Recent cost evaluations of several processes have indicated that, with some modifications and the application of new or improved technology, our domestic resources might become competitive with imported bauxite. In the long-term national interest of developing an economically viable process for utilizing domestic aluminum resources, we believe that the technology for recovering alumina from clay and other domestic raw materials should be brought up to date.

The purpose of this research effort is to test and develop the most promising technologies in a small-scale continuous pilot plant. New improvements and approaches developed by industry and the government for recovering alumina from clay, anorthosite, alunite, and dawsonite will be tested and evaluated in the plant to obtain enough information on which to form a judgment regarding the best processes for commercial adoption. A continuous mini-plant having a feed rate of about 70 pounds per hour of raw clay or other aluminum-bearing raw material is being operated to investigate the nitric acid process for recovering alumina from clay. Parts of this plant will be used subsequently for work on other processes for recovering alumina from clay, anorthosite, alunite, and dawsonite.

This work, which began July 1, 1973, is currently funded at $400,000 a year at the Boulder City (Nevada) Metallurgy Research Laboratory with another $100,000 for engineering and support activities at other Bureau installations. At this rate of funding, the proposed program will take a total of 6 years. In order to accelerate the program, the Bureau of Mines is inviting the U. S. aluminum producing industry and interested companies, as individual firms, to contribute another $400,000 a year for 3 years beginning July 1, 1974. The cooperative program should yield by June 30, 1977, a thorough engineering and cost assessment of several technologies for recovering alumina from domestic nonbauxitic resources. This information, in turn, will allow rational decision making on carrying the best processes to the next development and demonstration stage."

The U. S. Bureau of Mines mini-plant operation for processing kaolin with nitric acid is scheduled to be in continuous operation by the end of March 1974. Final conclusions on the nitric acid process will be drawn and the report on the research will be written beginning the first of May 1974. Additional runs on other processes will be started upon completion of the testing of the nitric acid process.

The objective of the original research and study conducted during Fiscal Year 1972 was to determine what action would be necessary to stimulate the production of alumina from Georgia kaolin and to indicate what specific steps would have to be taken to implement the study's findings. The report, "Alumina from Kaolin Potentials," was published April 1972 and drew several conclusions and made specific recommendations. One of the recommendations was that direct full funding be allocated to be used or administered by the Bureau of Mines, U. S. Department of the Interior, in cooperation with industry, for the purpose of definitive research directed toward obtaining the best economic and technical method(s) for obtaining alumina from domestic sources in large supply.

The recommendation for a U. S. Bureau of Mines pilot operation has been implemented by the establishment of the mini-plant at Boulder City, Nevada.

The funding and size of the pilot plant is not as large as recommended, but would appear to be a good choice in that greater flexibility of experimentation on various processes is permitted on an integrated comparative basis.

Other recommendations directed toward support of the project by the General Assembly of Georgia, the Governor of Georgia, and other high officials have been carried out by the support received.

The Georgia General Assembly has indicated its support for the establishment of an alumina industry in Georgia, as evidenced by the Georgia Senate passing a resolution for a constitutional amendment to allow the state to pay $250,000 to the first firm that establishes a plant capable of extracting alumina from Georgia kaolin. The Kaolin and Processing Committee of the Georgia House of Representatives has conducted hearings on a similar resolution and has indicated its intention to submit the resolution to the House. One of the recommendations of this committee is "The valuable research done by the Engineering Experiment Station at Georgia Tech should be continued, and the General Assembly should support that research as necessary."

In the recent months there is evidence of a considerable amount of interest in developing domestic sources of raw materials for the minerals industry. Our report two years ago advocated this step. In the briefing material developed and in the briefings conducted with government and industry, it was advocated in 1972 that the federal government state as national policy the implementation of an economically competitive, self-sufficient domestic alumina-aluminum supply to reduce the dependence of the United States on foreign bauxite for alumina and aluminum.

Plans are being made for a meeting of major aluminum ore producing nations in February 1974. Countries invited by host Guinea include Australia, Jamaica, Surinam, and Guyana. Yugoslavia also may participate. The results of this meeting will be watched very closely by all those concerned with aluminum.

The American Institute of Mining, Petroleum, and Metallurgical Engineers (AIME) will hold its annual meeting in Dallas, Texas, February 24-28, 1974. Several papers of interest to this project will be presented.

Stanley V. Margolin and Richard W. Hyde, Arthur D. Little, Inc. will discuss: "The ADL Nitric Acid Process for Recovery of Alumina from Aluminum-Bearing Minerals."

Dr. John E. Husted of the research team will discuss: "Potential Reserves of Domestic Non-Bauxite Sources of Aluminum."

W. W. Walker and D. N. Stevens, Earth Sciences, Inc. will discuss: "The Earth Sciences -- National-Southwire Alumina-to-Alunite Project."

Contact has been maintained with Donald F. Meyers, Division of Industrial and Strategic Minerals, U. S. Department of State, who states that he has discussed our report "Alumina from Kaolin Potentials" with a number of people and quite a bit of interest has resulted.

Contacts have been maintained with several aluminum companies who continue to profess their interest in alternate sources of raw materials for the production of alumina. It is considered that the response to the U. S. Bureau of Mines invitation for industry participation in the cooperative cost-sharing research program will be indicative of real interest in finding an economical solution to the problem.

The plans and objective of the research team in the coming quarter is to continue to work with industry to assist them in arriving at a positive decision to enter into alumina production from Georgia's kaolin. The research team also plans to continue work with governmental agencies to determine what additional efforts will be undertaken in the future. Specifically we shall continue to work with the U. S. Bureau of Mines to determine what results are obtained from the mini-pilot plant operations and what can and will be done with these results to hopefully influence favorable decisions by industry. The progress made by the U. S. Bureau of Mines on its cooperative cost-sharing research program will be closely monitored.

To this end, Dr. John E. Husted will explore all possibilities with those people in attendance at the American Institute of Mining, Petroleum, and Metallurigical Engineers (AIME) annual meeting the last of February, 1974. The standing invitation from the U. S. Bureau of Mines to visit the mini-pilot plant site to observe operations and discuss preliminary results will probably be accepted the latter part of the coming quarter, provided the announced schedule is met.

Sincerely,

William C. Ward, Jr.
Head, Industrial Services Branch

WCWJr:sw
Enclosure

cc: Mr. Ross W. Hammond
Dr. John E. Husted
Mr. William C. Hawthorne (10)
ORA (2)
File A-1458

A- 1458

OFFICE OF THE DIRECTOR

U.S. DEPARTMENT OF THE INTERIOR March 3, 1849

United States Department of the Interior

BUREAU OF MINES
WASHINGTON, D.C. 20240

In Reply Refer To:
EBM-MRED-Met

January 21, 1974

Dr. John E. Husted
Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Georgia 30332

Dear Dr. Husted:

We have been directed by Secretary Morton to step up our negotiations with individual firms in the domestic aluminum industry to finalize our cost-sharing pilot-plant research program.

In the long-term national interest of developing an economically viable process for utilizing domestic aluminum resources, the Bureau of Mines about a year ago initiated a new research program to bring up-to-date the technology for recovering alumina from clay and other domestic raw materials. The purpose of this research is to test and develop the most promising technologies in a small-scale continuous pilot plant. New improvements and approaches developed by industry and the Government for recovering alumina from clay, anorthosite, alunite, and dawsonite will be tested and evaluated in the plant to obtain enough information on which to form a judgment regarding the best processes for commercial adoption.

Currently, a continuous miniplant having a feed rate of about 70 pounds per hour of raw clay or other aluminum-bearing raw material is being operated to investigate the nitric acid process for recovering alumina from clay. Parts of this plant will be used subsequently for work on other processes for recovering alumina from clay, anorthosite, alunite, and dawsonite.

This work, which began July 1, 1973, is currently funded at $400,000 a year at the Boulder City (Nevada) Metallurgy Research Laboratory with another $100,000 for engineering and support activities at other Bureau installations. In order to accelerate the program, the Bureau of Mines is inviting the U.S. aluminum-producing industry and interested companies, as individual firms, to contribute at least another $400,000 a year for 3 years beginning July 1, 1974. Each participant in the cooperative cost-sharing program will be asked to contribute $50,000 a year. The cooperative program should yield by June 30, 1977, a thorough engineering and cost assessment of several technologies for recovering alumina from domestic nonbauxitic resources. This information, in turn, will allow rational decisionmaking on carrying the best processes to the next development and demonstration stage.

Ltr. to Dr. Husted, Georgia Institute of Technology, Subj: Negotiations with individual firms on miniplant project to evaluate alumina recovery processes.

Because of your concern with the maintenance of an adequate domestic supply of alumina, we are enclosing for your consideration our program, "Alumina From Domestic Resources, a Miniplant Project to Evaluate Alumina Recovery Processes." We invite you to participate in the program. If you are in agreement with our general concept, we will be happy to discuss specific details of implementing a cooperative effort with your firm. The Bureau's representative for this program is Carl Rampacek, Assistant Director--Metallurgy, U.S. Bureau of Mines, Room 3512, Interior Building, 18th and E Streets, NW., Washington, D.C. 20240. His telephone number is (202) 343-8311. He will be happy to meet with you or your representatives, or respond to questions regarding the program.

We hope you will join us in what we believe is an effort that is vital to the Nation.

Sincerely yours,

Assistant Director

Enclosure

A-1458

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

May 1, 1974

Georgia Department of Community Development
Trinity-Washington Building
Post Office Box 38097
Atlanta, Georgia 30334

Attention: Mr. James O. Bohanan

Subject: Quarterly Progress Report (No. 7) on Industrial Development Research Project No. A-1458 "Implementation of Alumina from Kaolin Potentials" Period February 1, 1974 - April 30, 1974

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following quarterly progress report is submitted.

Again, the keynote of the seventh quarter of this project was the continued and increased interest of both industry and governmental agencies on specific actions required to implement the potential development of producing alumina from non-bauxite sources. This interest has been manifested by: the response from industry to the invitation, from the U. S. Bureau of Mines, to participate in the research effort being conducted at the pilot plant operation effort being conducted at the Boulder City (Nevada) Metallurgy Research Laboratory; the contacts made and comments on the related papers presented at the annual meeting of the American Institute of Mining, Petroleum, and Metallurgical Engineers (AIME) in Dallas, Texas, February 24-28, 1974; the U. S. governmental agencies' monitoring of the conference of bauxite-producing countries held in Conakry, the Republic of Guinea, from the fifth to eighth of March, 1974; and the passing by both the House and Senate of the Georgia General Assembly of a resolution for a constitutional amendment to allow the state to pay $250,000 to the first firm that establishes a commercial plant capable of extracting alumina from Georgia kaolin.

Major events are as follows:

Dr. John E. Husted presented a paper "Potential Reserves of Domestic Non-Bauxite Sources of Aluminum" on February 25, 1974, to the Metallurgical Society (TMS) of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) at the AIME annual meeting in Dallas, Texas. As a result of this paper, several companies showed interest in alumina from kaolin. Among them were Alcan Aluminum Limited, Aluminum Company of America, Martin-Marietta Corporation, the Chase Manhattan Bank, Applied Aluminum Research Corporation, AMAX Pacific Aluminum Corporation, Chemical and Metallurgical Research, Inc., Beth-Elkhorn Corporation (subsidiary of Bethlehem Steel Corporation), the Superior Oil Company, Union Oil Company of California, and Atlantic-Richfield Company. Discussions were held with representatives of these companies with indications that visits by interested companies will be made to Georgia in the future.

One such visit has already taken place. The Vice President, Exploration, of an aluminum company, visited with Bill Ward and John Husted on March 25, 1974.

In the Spring of 1973 the Georgia Department of Community Development sent a letter to each of the kaolin-producing companies within the State of Georgia inquiring as to single body reserves of at least 150 million short tons, averaging 35 percent or greater alumina, which could be made available for use as an ore of aluminum. Such availability being either as a lease or sale. Four companies responded favorably. They were: 1) Anglo-American Clays Corporation; 2) Georgia Kaolin Company; 3) Horton International, Inc., and 4) Thiele Kaolin Company.

John Husted and the aluminum company executive visited all four kaolin companies for the purpose of verifying kaolin reserves and their availability for the production of alumina. This executive was convinced that kaolin reserves are present and expressed a desire to return for further discussion at a later date.

Following the visit, correspondence and telephone calls were received from Cecil Hodges of Cecil Hodges Lumber Company in Sandersville to indicate that he had done some preliminary testing and was of the opinion that he also could meet the above criteria and would be willing to make the kaolin available to an aluminum company. This information was forwarded to the interested aluminum company, along with a geologic map of Georgia and other requested data.

At the meeting of the Southeastern Section of the Geological Society of America held in Atlanta April 4 and 5, 1974, the discussions were held with geologists knowledgeable of the western end of the Georgia kaolin belt, who indicated that our estimates of reserves for that area could be quite low.

Information has been discussed concerning direct reduction of kaolin to aluminum by two distinctly different processes. While this information is proprietory, if they are feasible they will enhance the production of aluminum from Georgia kaolin.

Contact has been maintained with Donald F. Meyers, Division of Industrial and Strategic Minerals, U. S. Department of State. Mr. Meyers states that the State Department is watching closely the potential coalition of countries supplying the United States with critical raw materials, such as bauxite and alumina, in the manner of the oil-producing countries.

The planned meeting of major bauxite-producing nations, which was reported in the last quarterly report, received considerable comment in the newspapers, both editorially and as a news item, and did take place.

Ministers of the governments of Australia, Guinea, Guyana, Jamaica, Sierra Leone, Surinam and Yugoslavia met in conference in Conakry, the Republic of Guinea March 5-8, 1974. The purpose of the conference was to discuss what actions should be taken with regard to their bauxite industries. At the end of the conference, the ministers agreed to establish an inter-governmental association of bauxite-producing countries, called the International Bauxite Association (I.B.A.). In addition, the ministers agreed with the objective of securing effective national control over their bauxite industries and of maximizing national ownership of such industries.

A copy of the Communique issued upon the completion of the conference is attached to this report.

The objective of securing national control over the bauxite industries and of maximizing national ownership of such industries puts the U. S. aluminum industry in an even more precarious position in relation to raw materials. This in turn puts kaolin as a domestic source of alumina in a more favorable position. It is believed that actions taken by the bauxite-producing nations have contributed to the increased interest in the potential of producing alumina from kaolin.

The research team will monitor closely the expected ratification of the Agreement by the member countries of the International Bauxite Association (I.B.A.) and the next Ministerial Conference to be held in Georgetown, Guyana, during 1974.

It was reported in the last quarterly report that the Georgia Senate passed a resolution for a constitutional amendment to allow the state to pay $250,000 to the first firm that establishes a plant capable of extracting alumina from Georgia kaolin. The Georgia House of Representatives also passed the resolution during the quarter. The constitutional amendment will be submitted to the voters for ratification at the general election in November, 1974.

Frequent contacts have been made throughout the quarter with Carl Rampacek, Ralph Kirby, and Sheldon Wimpfen, U. S. Bureau of Mines, to remain current on the progress of the mini-pilot plant operation at Boulder City, Nevada, using Georgia kaolin for the production of alumina. These people have all visited the pilot plant and report that the operation is on schedule. It is reported that as a result of operations to date, several new patents were being applied for that should prove interesting. Information received from the U. S. Bureau of Mines indicates that the Bureau has received replies from four companies indicating their desire to contribute $50,000 per year each to accelerate the research being conducted.

The pilot plant has operated with nitric acid on the leaching and impurity removal phases of the process, with reported excellent success and some patents. The plant is incorporating the new innovations into the system with the completed system, expected to have been in operation the week of April 15. Fully integrated operation is not expected until the latter part of May.

The project is being kept before the public as evidenced by numerous newspaper articles discussing the alumina from kaolin potentials. The Atlanta Journal and The Atlanta Constitution both carried articles on their business page (March 28) concerning aluminum and Georgia's kaolin potential of becoming a major alternative to bauxite as a source of aluminum.

Chemical Week reported in its March 6, 1974 issue that concern about potential bauxite squeeze has aluminum makers searching for ways to unlock alumina from shales and clays. This article commented on the proposed financial incentive, by the State of Georgia, to the first commercial producer of alumina from the State's vast kaolin deposits and acknowledged that Georgia has been promoting such a project for several years.

Other articles have appeared in the Engineering Mining Journal, Business Week, and Chemical and Engineering News which address the problem of the aluminum industry's reliance on foreign sources of raw materials, prices, and vulnerability in these areas.

The continuing and increasing interest by industry in non-bauxite sources of aluminum raw materials is evidenced by these newspaper and trade journal articles. Such articles keep the issue before the industry on a continuing basis.

The plans and objective of the research team in the coming quarter is to work with industry to assist them in arriving at a positive decision to enter into alumina production from Georgia's kaolin. The research team also plans to continue work with governmental agencies to determine what additional efforts will be undertaken in the future. Specifically, we shall continue to work with the U. S. Bureau of Mines to determine what results are obtained from the mini-pilot plant operations and what can and will be done with these results to hopefully influence favorable decisions by industry. The progress made by the U. S. Bureau of Mines on its cooperative cost-charing research program, with those companies who responded favorably, will be closely monitored.

To this end, the research team will explore all possibilities with those companies which expressed interest in alumina from kaolin at the February, 1974 AIME annual meeting. In addition, the research team plans to visit the U. S. Bureau of Mines' mini-pilot plant site to observe operations and discuss preliminary results the latter part of May, 1974. Information received from the U. S. Bureau of Mines indicates that this would be a good time for such a visit.

A proposal for the continuation of the project through fiscal year 1975 has been submitted. A part of this proposal is to update the "Alumina from Kaolin" report to reflect changes that have occurred since publication. In anticipation of continuation of the project, certain information will be compiled during the quarter to allow for an update in a timely fashion.

The objective of the update is changed somewhat from the publication "Alumina from Kaolin Potentials" in that the first publication needed to call attention to the problems of foreign bauxite and to equally call attention to the use of kaolin as an alumina source with a possible economically competitive position.

The change in international economic conditions has caused a change in the relative economic positions of bauxite and kaolin in a manner that appears to favor kaolin over bauxite. Hence it is of prime importance to now develop specific information relative to fuels and their cost, water transportation, etc. in order to be ready for an alumina from kaolin industry. As the "Alumina from Kaolin Potentials" served to focus attention on Georgia kaolin, it is hoped that the update will serve to motivate that attention into ongoing action.

Sincerely,

William C. Ward, Jr.
Head, Industrial Services Branch

WCWjr:sw
Enclosure

cc: Mr. Ross W. Hammond
Mr. William C. Hawthorne (10)
Dr. John E. Husted
ORA (2)
File A-1458

COMMUNIQUE

Ministers of the governments of Australia, Guinea, Guyana, Jamaica, Sierra Leone, Surinam and Yugoslavia met in conference in Conakry, the Republic of Guinea, from the 5th to the 8th of March, 1974. The Conference was opened by H. E. Ahmed Sekou Toure, President of the Republic of Guinea, at whose invitation the Conference was held in Conakry.

In his inaugural address, President Ahmed Sekou Toure traced the history of the economic relationship between the industrialized and the colonial countries and the course of neo-colonialism and neo-imperialism. He analysed in depth the inequality which exists in the terms of trade between the developed countries, producers of manufactured products, and the undeveloped countries, the suppliers of raw materials from which these products are manufactured. He described the Conference as a firm beginning of a new era in international economic relationships. He urged the participating countries never to weary in their efforts to attain economic independence and expressed his firm conviction that the most effective means of achieving this independence is through close cooperation and the harmonization of their economic policies.

President Ahmed Sekou Toure declared on behalf of all the participating countries that this Conference and the cooperation which is being sought between the bauxite-producing countries is not directed against any consuming country or any group of consumers. It is rather an effort to organize against an unjust system, an effort to establish the machinery through which unified action can arrive at a permanent and stable economic relationship with the industrialized countries based on fairness, equality and justice. The Ministers, having heard the address by H. E. President Ahmed Sekou Toure, decided unanimously to incorporate the full text of the inaugural address in the record of the proceedings of the Conference.

At the end of the Conference, the Ministers agreed to establish an intergovernmental association of bauxite-producing countries, called the International Bauxite Association (I.B.A.), and representatives of the above governments signed the Final Act of the Conference.

The Association will come formally into existence as soon as the founding members have completed the procedures required by their constitutions in order to give effect to their membership.

The headquarters of the Association will be established in Kingston, Jamaica. Its principal organs will be a Council of Ministers, an Executive Board, and a Secretariat.

The creation of the Association is an expression of solidarity among the bauxite-producing countries and of their determination to cooperate with each other in order to safeguard their common interests.

Provisions have been made in the Agreement for the governments of other bauxite-producing countries to become members.

Ministers expressed their intention to secure on behalf of their peoples fair and equitable returns from the exploitation of their bauxite resources in order to promote their social and economic development. This was particularly important because the majority of the bauxite-producing countries are developing countries with low standards of living and high rates of unemployment. They will, however, bear in mind the recognized interests of the consumers of bauxite products.

Ministers agreed with the objective of securing effective national control over their bauxite industries and of maximizing national ownership of such industries. They will endeavor to ensure that the operations or projected operations of multinational corporations in any member country will not be permitted to damage the interests of another member country.

The Conference unanimously elected Mr. Henri Guda of Surinam as Secretary General of the Association.

The next Ministerial Conference will be held in Georgetown, Guyana, within two months of the ratification of the Agreement by the member countries, or in any case during 1974.

Representatives of the other participating countries expressed their gratitude to the President of the Republic of Guinea for the interest taken by the government and people of Guinea in the creation of the International Bauxite Association and for the generous hospitality which they received throughout the period of the Conference.

Conakry,
Republic of Guinea
9 March 1974

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

August 1, 1974

Georgia Department of Community Development
Trinity-Washington Building
Post Office Box 38097
Atlanta, Georgia 30334

Attention: Mr. James O. Bohanan

Subject: Quarterly Progress Report (No. 8) on Industrial Development Research Project No. A-1458 "Implementation of Alumina from Kaolin Potentials" Period May 1, 1974 - July 31, 1974

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following quarterly progress report is submitted.

As was the case during the seventh quarter, the keynote of the eighth quarter of this project was the continued and increased interest of both industry and governmental agencies on specific actions required to implement the potential development of producing alumina from nonbauxite sources. As a result of this increased interest, there was a pronounced increase in activity related to the use of kaolin as a source of aluminum. This interest and activity has been manifested by: the attendance by representatives from the primary aluminum industry, kaolin producers, and agencies of the State of Georgia at the U. S. Bureau of Mines, Metallurgy Research Laboratory, Boulder City, Nevada, Nitric Acid Alumina-from-Kaolin miniplant demonstration during the period May 30, 1974 to June 4, 1974; the visits to the Georgia kaolin belt by representatives of aluminum companies; the concern expressed by aluminum companies to the Jamaican tax action; and the expressed desire by several aluminum companies for information on availability of kaolin in large quantity, process water, transportation, fuel, and process chemicals.

Major events are as follows:

The research team (William C. Ward, Jr., and Dr. John E. Husted), Robert A. Rotan, Jr., Georgia Department of Community Development, Frank Martin, Georgia Department of Natural Resources, visited the U. S. Bureau of Mines, Metallurgy Research Laboratory, Boulder City, Nevada, during the period May 30, 1974 to June 2, 1974 to observe the operation of the nitric acid leach miniplant for production of alumina from Georgia kaolin. The laboratory designated this particular operation a campaign and considered it demonstrated many important principles and techniques. The nitric acid process used was a modified Arthur D. Little, Inc. process, with the major changes being in the use of three-step cascade leaching instead of a single vessel and a molten salt heat exchange for driving off water and HNO_3 to recover the Al_2O_3 instead of a fluid bed reactor. The molten salt heat exchange has had a patent applied for by the U. S. Bureau of Mines. Both modifications should result in simpler, less costly construction and probable reduction in energy requirements. The miniplant was in operation on a continuous basis for almost seven days. The total material feed was 26,782 pounds of Georgia kaolin, containing 38.1 percent Al_2O_3 on a dry basis.

Work is planned by the U. S. Bureau of Mines to continue testing the nitric acid method at least into September, when another integrated circuit campaign will be conducted. As a result of the July and September campaigns, definitive operational costs and staffing requirements will be available.

Several aluminum companies were represented at the miniplant campaign to observe operations. Among those present were Alcan Aluminum, Ltd., Aluminum Company of America, American Metal Climax, Inc., Kaiser Aluminum & Chemical Corp., Martin-Marietta Aluminum, Inc., National-Southwire Aluminum Company, Noranda Mines, Ltd., Pechiney Ugine Development Kuhlmann, Inc., and Reynolds Metals Company.

In addition, several kaolin companies had representatives present at the miniplant demonstration. Among those attending the campaign were Horton International, Inc., J. M. Huber Corporation, and Freeport Kaolin Company.

Indications from the miniplant operations are that the nitric acid method of producing alumina from Georgia kaolin was technically and economically feasible, as previously stated by the research team from Georgia Tech. The major difficulty with a nitric acid method is one that was not recognized until the last six months, namely a shortage of nitric acid resulting from lack of availability of natural gas (used to make anhydrous ammonia) and competition for anhydrous ammonia (used to make nitric acid) from the fertilizer industry.

The acute ammonia shortage places considerably more emphasis on the use of hydrochloric acid process to produce alumina from kaolin. Fortunately, (1) the Anaconda Company successfully piloted hydrochloric acid process about ten years ago, (2) the U. S. Bureau of Mines is preparing to test hydrochloric acid process with construction underway for a miniplant at Boulder City, Nevada, and (3) hydrochloric acid appears to be available, both short and long term, at prices that should permit an alumina from kaolin hydrochloric acid process to be competitive with bauxite.

As was reported in previous quarterly reports, the U. S. Bureau of Mines has invited the U. S. aluminum-producing industry and interested companies, as individual firms, to contribute $50,000 per year for three years beginning July 1, 1974, toward a cooperative program of research into recovering alumina from domestic nonbauxite resources.

To date we have received information that six primary aluminum producers have signed a cooperative agreement with the U. S. Bureau of Mines to contribute $50,000 per year toward construction and operation of mini-pilot plants using kaolin and other domestic nonbauxite sources of aluminum. One other company has sent in their check and is expected to sign the agreement, and still another company is also expected to sign an agreement in the very near future, giving a total of eight primary aluminum companies cooperating with the U. S. Bureau of

Mines. Of these companies, five have contacted the research team at Georgia Tech and are either seeking or have Georgia kaolin reserves. Of the remaining three or four companies, indications are that they also are looking toward Georgia for kaolin reserves.

Of the above primary aluminum companies, three have sent representatives to visit with the research team. Dr. John E. Husted has accompanied geologists from two companies to introduce them to kaolin owners who had indicated, in writing, that they had minimum reserves of 150 million short tons of kaolin in a contiguous body containing 35 percent or greater alumina (Al_2O_3) that they would negotiate with a primary aluminum company for use as an ore of aluminum. A geologist of a third company was directed to these same kaolin owners. He did not wish to be accompanied, as he was familiar with the companies and area. Two additional primary aluminum companies already have kaolin reserves.

The objective of bauxite producing countries of securing effective national control over their bauxite industries and of maximizing national ownership of such industries was reported in the last quarterly report.

Several actions toward implementation of this objective have occurred during the present quarter. The most notable action taken was by Jamaica to increase royalties for mining Jamaican bauxite. The royalty level was increased from $2.48 a ton to $12.23 a ton, a five-fold increase. The higher taxes were effective June 22, 1974, and the aluminum companies are making the additional payments required under the Jamaican law.

This action has caused concern among aluminum companies that are heavily dependent on Jamaica for their bauxite supplies. The companies are: Aluminum Company of America, Alcan Aluminum Ltd., Reynolds Metals Co., Kaiser Aluminum & Chemical Corp., Anaconda Co., and Revere Copper & Brass, Inc.

Three of these companies, Aluminum Company of America, Kaiser Aluminum & Chemical Corp., and Reynolds Metals Co., have disputed the increased taxes and have asked the World Bank International Center for Settlement of Investment Disputes to arbitrate their dispute with Jamaica.

Jamaican bauxite and alumina supplies today account for 40 percent of the aluminum produced in the U. S.

Aluminum Company of America gets 15 percent of its alumina from Jamaican bauxite, Reynolds Metals Co. gets 60 percent of its bauxite from Jamaica, and between 70 and 75 percent of Kaiser Aluminum & Chemical Corporation's U. S. alumina requirements are totally dependent on Jamaican bauxite.

The aluminum industry takes a serious view of the increased taxes because it fears that if Jamaica sets an unreasonably high price, other members of the International Bauxite Producers Association would follow suit.

In addition to the tax hike, Jamaica desires a new partnership between the aluminum companies operating in Jamaica and the Jamaican government. Jamaica intends to negotiate repurchase of the surface rights of the lands now owned by the aluminum producers. Jamaica's desire is also to achieve, in the long run, an equity ownership position in bauxite and alumina companies operating in Jamaica.

Prime Minister Manley stated that Jamaica also would develop facilities for processing bauxite into alumina. This would be a step toward announced plans for building, in conjunction with Guyana and Trinidad-Tobago, an aluminum smelter in southern Trinidad. The three countries said construction of the smelter will begin in January 1976, with production anticipated in January 1979. Trinidad-Tobago would have 34 percent interest in the smelter, with Jamaica and Guyana each having a 33 percent holding.

Major aluminum producers increased the price of primary aluminum ingots from 31.5¢ per pound to 33.5¢ effective June 1, 1974, and have announced a second increase to 36¢ to 38¢ per pound effective August 2, 1974. Prices may be as high as 40¢ by the end of the year.

The action by Jamaica has caused the aluminum industry to take an active interest in developing alternate sources of aluminum. This active interest is shown in the visits to Georgia's kaolin belt for the purpose of acquiring kaolin reserves. It is also revealed by a statement of the Chairman of the Board of Alcoa that future expansion would be in the United States.

Aluminum Company of America and Anaconda Company have agreed to exchange information on the technology of producing alumina from ores other than bauxite. Both companies have experimented with ways of producing alumina from nonbauxite ores. Anaconda has produced alumina from Georgia kaolin in a pilot plant using the hydrochloric acid process and then produced aluminum from this alumina. It is reported that Aluminum Company of America is experimenting with an alumina from coal waste process.

The visits by aluminum companies to kaolin owners for the purpose of securing kaolin reserves; the interest in the results of the miniplant operation; and the willingness of companies to work together and exchange information, leads the research team to the conclusion that positive decisions relating to an alumina from kaolin plant will be made in the next six to twelve months. It is also believed that if the decision is to establish an alumina plant, the first plant will be undertaken jointly by two or three companies together, rather than by one company, and that ground will be broken on such a plant within 12 to 18 months because of the urgency of the Jamaican situation.

The project is being kept before the public by numerous newspaper articles discussing the alumina from kaolin potentials. Two articles directed at this subject appeared in the June 9, 1974 issue of The Atlanta Journal and Constitution. Other articles related to the general subject have appeared in The Washington Post and The Wall Street Journal.

Additional articles have appeared in Chemical Week, Business Week, Iron Age, and Engineering Mining Journal, which address the problem created and the potential use of nonbauxite sources of alumina. Publicity, however, is not being sought at present in order to allow the aluminum companies the opportunity of less pressure concerning domestic negotiations.

Frequent contacts have been made throughout the quarter with Carl Rampacek, Ralph Kirby, Don Baker, and others with the U. S. Bureau of Mines, to remain current on the progress and future plans for their research program. Contacts have also been made to other governmental agencies to secure information on related subjects.

Work was begun during the month of June in assembling data to be included in the updated report on "Alumina from Kaolin Potentials."

The plans and objective of the research team in the coming quarter is to continue to work with industry to assist them in arriving at a positive decision to enter into alumina production from Georgia's kaolin. The research team also plans to continue work with governmental agencies to determine what additional efforts will be undertaken in the future. Specifically, we shall continue to work closely with the U. S. Bureau of Mines to determine what results are obtained from the miniplant operations and what can and will be done with these results to influence favorable decisions by industry.

The research team plans to attend the second nitric acid integrated circuit campaign at Boulder City, Nevada, in September 1974. Definitive cost information should be forthcoming from this campaign.

All possibilities will be explored with those companies which have expressed interest in alumina from kaolin, as well as those that have contacted us for assistance and information.

Work will be continued on gathering information for and writing sections of the updated report.

A contract for the continuation of the project through fiscal year 1975 has been signed.

Sincerely,

William C. Ward, Jr.
Head, Industrial Services Branch

WCWjr:sw

cc: Mr. Ross W. Hammond
Mr. William C. Hawthorne (10)
Dr. John E. Husted
ORA (2)
File A-1458

File: A-1458

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

November 1, 1974

Georgia Department of Community Development
Trinity-Washington Building
Post Office Box 38097
Atlanta, Georgia 30334

Attention: Mr. James O. Bohanan

Subject: Quarterly Progress Report (No. 9) on Industrial Development Research Project No. A-1458 "Implementation of Alumina from Kaolin Potentials" Period August 1, 1974 - October 31, 1974

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following quarterly progress report is submitted.

The keynote of the ninth quarter of this project was the research done to gather information for the report to be published next quarter. There is indication of continued and increased interest by industry on the potential of producing alumina from kaolin. We have received several requests for copies of our 1972 report and requests for the new report to be published next quarter.

Major events are as follows:

As was reported in the last quarterly report, the U. S. Bureau of Mines, Metallurgy Research Laboratory, Boulder City, Nevada is continuing testing the nitric acid method of producing alumina from Georgia kaolin. The laboratory ran another campaign during the period October 21-26, 1974. The purpose of this particular operation was to refine the data obtained from the June campaign and to prepare for an extended operation of the nitric acid process during the period November 11-23, 1974. Indications are that the November operation will be the final testing of a nitric acid process which will provide definitive data for the decision making process.

Construction has begun, at the Boulder City Laboratory, on a miniplant for testing a hydrochloric acid process for producing alumina from Georgia kaolin. A 56.5 ton sample of Georgia kaolin has been shipped from a kaolin company to the Boulder City Metallurgy Research Laboratory for continuation of the miniplant research. In addition an aluminum company has furnished a large sample of clay with higher iron content for testing purposes.

To date eight primary aluminum companies are cooperating with the U. S. Bureau of Mines in the construction and operation of mini-pilot plants using kaolin and other domestic non-bauxite resources. A steering committee made up of representatives of the aluminum companies and the U. S. Bureau of Mines has been formed to guide the research being done at the Boulder City Laboratory. This committee met at Boulder City on October 21, 1974 to discuss plans for testing the hydrochloric acid process to be conducted upon completion of the nitric acid campaigns and construction of the hydrochloric acid process mini-plant. These members also observed the testing conducted during the week of October 21, 1974.

The International Bauxite Association (I.B.A.) was strengthened during the quarter. In late September 1974, Jamaican Prime Minister Michael Manley met with Australian Prime Minister Gough Whitlam and was assured that Australia will be an active member of the International Bauxite Association. There was some indication, earlier, that Australia would not completely support the objective of the Association. This doubt has been removed. This action by Australia completes the circle of leading bauxite producers and makes the International Bauxite Association all the more stronger. The next formal meeting of the I.B.A. is scheduled in November 1974, at Georgetown, Guyana.

The objective, of the I.B.A., of securing national control over the bauxite industries and of maximizing national ownership, of such industries, puts the U. S. aluminum industry in an even more precarious position in relation to raw materials. This, in turn puts kaolin, as a domestic source of alumina in a more favorable position. Actions taken by the bauxite producing nations have contributed to the increased interest in the potential of producing alumina from kaolin.

The Jamaican unilateral action toward implementation of the objective of the I.B.A. by increasing levies for mining Jamaican bauxite by more than 500 percent was reported in the last quarterly report. Guyana has also instituted a new tax on bauxite production by a U. S. aluminum company. Company estimates are that the tax is a 1,600 percent increase over the 1973 tax. In addition Guyana announced intentions to nationalize the aluminum company's operation. In 1971, Guyana nationalized the assets of a Canadian aluminum company, therefore the precedent has been set.

The Georgia Department of Community Development sent letters to 13 aluminum companies informing them that the 1974 Georgia General Assembly authorized a constitutional amendment that will provide $250,000 to the first company that established a kaolin to alumina processing facility in Georgia. This amendment will be voted on in the General Election November 5, 1974. In addition the Department informed the companies of the intended publication of an updated report and of the Deaprtment's desire to provide information and services to these companies as required. Several replies have been received expressing interest and a desire to discuss further the feasibility for the location of kaolin processing facilities in Georgia.

A representative of the Department of Community Development and a member of the research team met with and briefed a representative of a foreign international company on the potentials of producing alumina from kaolin. This company expressed an active interest in the project. In addition, representatives of the Department of Community Development briefed the President of another foreign company on the project. This company is a major user of aluminum and also expressed an active interest in the project.

The interest of aluminum companies desire to find an economical alternate to alumina from bauxite is indicated by the announced plans of at least two companies.

Pechiney Ugine Kuhlman (PUK), a French company, is planning a 20 tons per day pilot operation in France with start-up scheduled for late 1975. It would produce 20 tons of alumina a day from 60 to 100 tons of certain clays believed to be kaolin since the company is reported to have an interest in Georgia kaolin. The pilot plant could be fully operational by the end of 1976. PUK officials stated that the start-up dates for the pilot plant provide sufficient time to iron out technical problems before deciding to proceed with a full-scale alumina refinery. PUK's process involves sulphuric acid for digesting the ore because of its relatively low price and its low volatility which allows it to be used without difficulty in high concentrations and at high temperatures.

The Aluminum Company of America (Alcoa) faced with skyrocketing taxes and royalty payments in Jamaica is quoted as stating it has accelerated programs to develop commercial refining processes for a number of alternate ores. It is believed that one of these alternate ores is kaolin.

The project is being kept before the public by numerous newspaper and trade journal articles during the quarter. Among these are American Metal Market, Metals Week, Chemical Week, Engineering Mining Journal, Barron's, The Wall Street Journal, The Washington Post, The Atlanta Journal, and The Atlanta Constitution. These articles point up the interest in and need for developing a domestic source of alumina.

Frequent contacts have been made throughout the quarter with Carl Rampacek, Ralph Kirby and Frank Peters, U. S. Bureau of Mines, Washington, D. C., and with Don Kesterke and Don Baker, U. S. Bureau of Mines, Metallurgy Research Laboratory, Boulder City, Nevada, to remain current on the progress and future plans for their research program. Contacts have also been made with other agencies and industry to secure information on related subjects.

The U. S. Bureau of Mines has recently released, Bureau of Mines Information Circular IC 8648 "Revised and Updated Cost Estimates for Producing Alumina From Domestic Raw Materials." Cost estimates on a 1973 basis were included for the nitric acid and hydrochloric acid process for extracting alumina from kaolin using ion-exchange for removal of impurities. The ion-exchange methods are relatively recent developments and the Bureau had not published costs on these processes before.

We have taken the U. S. Bureau of Mines, estimated costs for the nitric acid and hydrochloric acid processes and updated estimated costs to conform with changes to October 1974. In our research into energy requirements and cost factors we have found that natural gas, which was used by the Bureau for heat energy, will not be available in the kaolin belt in the quantities required. Since natural gas is not available we must go to alternate sources of energy. This means the use of oil and coal. This results in increased costs. Based on a cost of $12 per barrel for number 2 fuel oil and $30 per ton for coal plus other costs which have increased the cost of producing a ton of alumina from kaolin is estimated to be approximately

$126 per ton using nitric acid and approximately $123 per ton using hydrochloric acid. This is versus an estimated $77.74 for nicric acid and $74.54 for hydrochloric acid by the Bureau using 1973 cost factors. These 1974 cost estimates could be reduced if an allocation of natural gas in quantities required were made to an alumina industry by federal authorities.

The plans and objectives of the research team in the coming quarter are to complete and publish the report "Alumina from Kaolin" and to continue to work with industry to assist them in arriving at a positive decision to enter into alumina production from Georgia's kaolin. The research team also plans to continue work with governmental agencies to determine what additional efforts will be undertaken in the future. Specifically, we shall continue to work closely with the U. S. Bureau of Mines to determine what results are obtained for the miniplant operations and what can and will be done with these results to influence favorable decisions by industry.

The research team plans to attend the last nitric acid integrated circuit campaign at Boulder City, Nevada, in November 1974. At that time we shall also observe the progress made on the installation of the hydrochloric acid miniplant and determine the schedule for future testing.

Assistance to the Georgia Department of Community Development will be continued as required.

Sincerely,

William C. Ward, Jr.
Head, Industrial Services Branch

WCW:js

cc: Mr. Ross W. Hammond
Mr. William C. Hawthorne (10)
Dr. John E. Husted
ORA (2)
File A-1458

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

May 1, 1975

Georgia Department of Community Development
Trinity-Washington Building
Post Office Box 38097
Atlanta, Georgia 30334

Attention: Mr. James O. Bohanan

Subject: Quarterly Progress Report (No. 11) on Industrial Development Research Project No. A-1458 "Implementation of Alumina from Kaolin Potentials," Period February 1, 1975 - April 30, 1975

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following quarterly progress report is submitted.

The keynote of the eleventh quarter of this project was the continued and increased interest and activity of both industry and government related to specific actions required to implement the potential development of producing alumina from kaolin. This interest and activity has been manifested by: the continued and expanded operation of the mini-plant research at the U. S. Bureau of Mines, Metallurgy Research Laboratory, Boulder City, Nevada; the indicated future action of the International Bauxite Association (IBA); the reaction of industry to the publication of the "Alumina from Kaolin" report; the visit to Georgia by industry executives to secure specific information needed in their decision making process; and the continued expressed desire of the U. S. Bureau of Mines to work with us on the alumina from kaolin development.

Major events are as follows:

On April 9, 1975 formal briefings on the project and visits to the kaolin area were conducted for the Executive Vice President and Chief Geologist of the Aluminum Company of America (Alcoa) and the President and Vice President-Treasurer of Pechiney Ugine Kuhlmann Development, Inc. (Pechiney). Representatives of the Georgia Department of Community Development, U. S. Bureau of Mines, Georgia Power Company, Southern Railway System, Trust Company Bank, Sandersville Railroad Company, and the Georgia Institute of Technology research team participated in the briefings and discussion. The briefings consisted of a brief history of the project to date, the Georgia Tech 1972 report, significant events that relate to the project which have occurred since the 1972 report, the 1974 conclusions and recommendations and costs as reported therin, the U. S. Bureau of Mines Research Program on alumina fron non-bauxite sources, kaolin reserves, and the economies of producing alumina from kaolin. Discussions were held with a kaolin company and holders of kaolin reserves in the kaolin area. Much interest was shown in the ecomomies of the process, capital costs, energy costs and availability of kaolin reserves. It is considered that both companies have a definite interest in the implementation of an alumina from kaolin process and received information which will be useful in their decision making process.

As was reported in the last quarterly report the "Alumina from Kaolin" report was distributed to both industry and governmental agencies. The report has created considerable interest and numerous requests have been received for copies from companies and individuals not on the initial distribution list. Other companies who received the report have requested additional copies and additional information.

One foreign corporation received copies of the reports on "Alumina from Kaolin" and stated that, in view of the future potential of non-bauxite minerals, they now have a more keen interest in this project. This company requested a sample of typical Georgia kaolin for their analysis.

An aluminum company met with representatives of the Georgia Department of Natural Resources to discuss the environmental considerations of producing alumina from kaolin in Georgia. It is understood that this company is doing some research on producing alumina from kaolin and is seriously considering a pilot plant operation. The high interest rates for borrowed capital and the weakness in the current price of aluminum is inhibiting their decision to proceed at this time. However, this company states that producing alumina from kaolin looks better all the time.

Another aluminum company is doing detailed engineering studies on an alumina from kaolin process with an indicated management decision, on whether or not to proceed with a pilot plant, to be forthcoming in the near future.

A major construction company was referred to the research team by an aluminum company to get a copy of the 1974 report and to discuss plant construction. The construction company stated that the aluminum company is proceeding with discussion of plans to construct a large sized plant to pilot alumina from kaolin production.

Another company requested a copy of the report and stated it was assessing its potential role in the realization of commercial plants based on Georgia kaolin.

Several aluminum companies have sent Geologist to Georgia to gather specific information on kaolin reserves for their companies.

The "Mining Congress Journal" for March 1975, lists Project A-1458, "Alumina from Kaolin", in their Report Corner. As a result of this listing requests for the report have been received from interested companies.

Dr. John E. Husted, a member of the research team, has submitted a research proposal entitled "Optimum Water Management In Kaolin Mining For Aluminum Production" to the U. S. Department of the Interior. It is understood that this research proposal has the support of the U. S. Bureau of Mines. If the proposed research is approved the results of the study should be most helpful to the potential alumina from kaolin industry. One of the items which concerns aluminum companies interested in producing alumina from kaolin is water management.

The International Bauxite Association (IBA) now consists of ten countries--Jamaica, Surinam, Guyana, the Dominican Republic, Haiti, Ghana, Guinea, Sierra Leone, Yugoslavia and Australia. The executive board of IBA in March 1975 began studying information furnished by member countries on the widely varying prices aluminum companies pay for bauxite from country to country. The board's objective is to see if it is possible to develop a common pricing formula that would set the price of any given deposit of bauxite ore. If all goes as planned the executive board will have the formula ready for the associations Council of Ministers, its policy-making body, to present to the aluminum world in November 1975. The common pricing formula is intended to replace the current special taxes levied by several member countries on an individual basis. The IBA now has 14 permanent staff on the board and expects to be up to full strength of 25 within five months.

The data secured from the nitric acid campaigns at the U. S. Bureau of Mines, Metallurgy Research Laboratory, Boulder City, Nevada has been sent to the College Park Metallurgy Research Center, College Park, Maryland for analysis and process evaluation. There are some gaps in the information which must be filled in before new cost figures can be published. Hopefully, the necessary data will be forthcoming and the evaluation completed during the next quarter. The information will be made available to us when it is finalized and evaluated.

The Boulder City Laboratory is proceeding with the installation of the hydrochloric acid process mini-plant. To date the leach tanks, settling tanks, and scrubbers are in, the tailings disposal area is set, and the plumbing and electric circuits are being installed. The Laboratory will probably start stage testing the process in late May with a full plant run conducted sometime the latter part of July.

The cooperative research program between the U. S. Bureau of Mines and Industry is proceeding on schedule. The next Steering Committee meeting to discuss the current status and approve plans for the future is scheduled at Boulder City, Nevada on May 22, 1975.

The U. S. Bureau of Mines FY76 budget request contains $2,000,000 for the purpose of detailed engineering design studies for alumina from non-bauxite sources. These design studies are to scale up mini-plants to a 50 ton-per-day or an optimum size large scale pilot plant. The designs will be done on several processes with view toward selection of at least one process for large scale pilot plant operation. It is intended that the design studies will be done on contract by private companies rather than in-house by the U. S. Bureau of Mines.

The Boulder City Laboratory will conduct one more integrated circuit campaign on the nitric acid process beginning on May 4, 1975. This will be the last nitric acid run as plans now stand. This run should supply all of the data necessary for final evaluation.

It was reported in the last quarterly report that Dr. Thomas V. Falkie, Director, U. S. Bureau of Mines had reviewed the "Alumina from Kaolin" report and stated that we should all work together on the alumina development so that alternative sources can be available in supplying the basic materials for aluminum production. As a follow up to working together Lt. General Louis W. Truman, Commissioner, Georgia Department of Community Development, his Deputy, James O. Bohanan and the research team will meet with Dr. Falkie in May to discuss mutual interests of developing a domestic source of alumina through the use of existing U. S. mineral resources.

The plans and objectives of the research team in the coming quarter are to continue to work with industry to assist them in arriving at a positive decision to enter into alumina production from Georgia's kaolin. The research team also plans to continue work with governmental agencies to determine what additional efforts will be undertaken in the future. Specifically, we shall meet with the Director, U. S. Bureau of Mines and shall continue to maintain close liason to determine what results are obtained from the mini-plant operations and what can and will be done with these results to influence favorable decisions by industry.

A member of the research team and a representative of the Georgia Bureau of Planning and Budget will visit the Boulder City Laboratory in May 1975 to observe the last nitric acid integrated circuit campaign and to discuss the project in general and plans for the future. They also will receive a briefing on the hydrochloric acid process and observe the current status of the installation of the HCL mini-plant.

We shall maintain frequent contacts throughout the quarter with the U. S. Bureau of Mines, Washington, College Park, and Boulder City to keep abreast of developments.

Assistance to the Georgia Department of Community Development will be continued as required.

Sincerely,

William C. Ward, Jr.
Head, Industrial Services Branch

WCW:js

cc: Mr. Ross W. Hammond
Mr. William C. Hawthorne (10)
Dr. John E. Husted
ORA (2)
File A-1458

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

August 1, 1975

Georgia Department of Community Development
Trinity-Washington Building
Post Office Box 38097
Atlanta, Georgia 30334

Attention: Mr. James O. Bohanan

Subject: Quarterly Progress Report (No. 12) on Industrial Development Research Project No. A-1458 "Implementation of Alumina from Kaolin Potentials," Period May 1, 1975 - July 31, 1975

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following quarterly progress report is submitted.

The keynote of the twelfth quarter of this project was the continuation of investigations by industry concerning acquisitions and evaluation of kaolin reserves for use as an ore of aluminum, as well as increased interest and activity of both industry and government related to specific actions required to implement the potential development of producing alumina from kaolin. This interest and activity has been manifested by: the continued and expanded operation of the mini-plant research at the U. S. Bureau of Mines, Metallurgy Research Laboratory, Boulder City, Nevada; industry evaluations both technical and economic; the continued economic pressure from bauxite producing countries; and the continued expressed desire of the U. S. Bureau of Mines to work with us on the alumina from kaolin development.

Major events are as follows:

On May 12, 1975, Lt. General Louis W. Truman, Commissioner, Georgia Department of Community Development, Mr. James O. Bohanan, Assistant Deputy Commissioner, and the Georgia Institute of Technology research team met with Dr. Thomas V. Falkie, Director, U. S. Bureau of Mines, Dr. Thomas A. Henrie, Associate Director, Mineral and Materials Research and Development, Mr. Carl Rampecek, Assistant Director, Metallurgy, and Mr. Ralph Kirby, Chief, Division of Metallurgy. The purpose of this meeting was (1) to reemphasize to U. S. Bureau of Mines personnel Georgia's interest in promoting the development of alumina from Georgia kaolin; (2) to make U. S. Bureau of Mines personnel aware of the State of Georgia's interest in and support of their research efforts to accelerate this development; and (3) to open a communications link for cooperative efforts between the Federal government and the State of Georgia on this development effort. General Truman gave a brief history of Georgia's efforts to promote alumina from kaolin and restated Georgia's desire to support the Bureau's research effort and offered his department's assistance in accelerating the development phases of a large scale pilot plant in Georgia. The meeting was a fruitful one and contained extensive discussion of ways to implement mutual interests of developing a domestic source of alumina through the use of existing U. S. mineral reserves. Dr. Falkie, as well as others of his staff, restated that we should all work together, including industry, on the alumina development so that alternative sources can be available in supplying the basic materials for aluminum production.

Mr. William C. Ward, Jr., Project Director, and Mr. John Overstreet, Program Administrator, Coastal Plains Regional Commission, Office of Planning and Budget, State of Georgia, visited the U. S. Bureau of Mines, Metallurgy Research Laboratory, Boulder City, Nevada, in May, to observe a research campaign on the nitric acid process. This run was made to supply the necessary data for final evaluation of the nitric acid process. A briefing on the status of the research and changes made in the process was received prior to observation of the actual operation. A briefing was also received on the status of the hydrochloric acid process mini-plant and an inspection was made of the equipment installed at that time. There had been some slippage in delivery of some equipment for the HCL plant but this equipment was expected shortly.

Subsequent to the visit to the Boulder City Laboratory, additional equipment has been received and installation is proceeding on schedule. The plan is to test each stage in sequence before making an integrated circuit campaign on the entire process. Stage testing of the leach section is scheduled beginning on August 10, 1975. No firm starting date for stage testing of the SX section has been established but is currently planned for late September or early October. Plans are to continue stage testing with a full integrated circuit run sometime later in the year. The schedule will probably be firmed up at the next Steering Committee meeting scheduled to meet in Washington, D. C., on August 22, 1975.

As a result of the meeting with Dr. Falkie, he has taken an even more personal interest in the alumina from kaolin project. Because of this personal interest, he has requested that the next Steering Committee meeting be held in Washington to enable him and other U. S. Bureau of Mines personnel to participate in the deliberations of the Committee.

The data from all of the nitric acid runs at the Boulder City Laboratory has been submitted to the U. S. Bureau of Mines, College Park Metallurgy Research Center, College Park, Maryland, for analysis and evaluation. Mr. Frank A. Peters, Research Supervisor, Process Evaluation, College Park Metallurgy Research Center, will present his evaluation of the nitric acid process to the Steering Committee at the August 22, 1975, meeting. This evaluation will include an overall evaluation, material balances, energy requirements, equipment sizing for a 1,000 ton per day of alumina plant, and operating and capital cost data. It is interesting to note that the energy requirements will include the use of coal in the process as well as oil instead of complete reliance on natural gas as has been done in the past. It is considered that this is a result of the position taken in the report "Alumina From Kaolin" published this year. The evaluation results will be made available to the research team after presentation to the Steering Committee.

The future of additional testing of the nitric acid process will depend on the industry feedback at the Steering Committee meeting in Washington. If both the U. S. Bureau of Mines and industry representatives are satisfied with the data available, the chances are that no additional testing will be required. If there are major questions as to the validity of certain data, additional testing may be required. In any event, the nitric acid mini-plant will be maintained intact to be available for future testing if required.

Mr. Frank A. Peters requested some wage rate information from us to be used in his cost estimates. This information was furnished.

The research team and Mr. James O. Bohanan met with the General Manager of Oglethorpe EMC and a representative of the Trust Company Bank to discuss the project and future potential of an alumina and aluminum industry in Georgia. Due to the long lead time for construction of electric power plants, the Oglethorpe EMC was interested in getting detailed information on total and peak power requirements and general location of a potential plant. The Trust Company Bank has been active in contacting aluminum companies to determine their interest in Georgia and desires to be an active member of the team in efforts to implement an alumina from kaolin industry in Georgia. We plan to work closely with both these organizations as the project proceeds.

The continued interest of industry in the project is evidenced by the numerous requests for copies of the "Alumina From Kaolin" report and other actions. In addition to a continuation of investigations, by industry, concerning acquisition and evaluation of kaolin reserves in Georgia, other industry evaluations, both technical and economic, have been reported.

The continued economic pressure from bauxite producing countries is particularly indicated by the actions of Jamaica. Jamaica is moving forward in three directions: more government revenue from bauxite, government ownership of 51 per cent of the companies located there, and a higher price for bauxite on the world market. Five companies are involved. They are Aluminum Company of America (Alcoa), the Aluminum Company of Canada (Alcan), the Kaiser Aluminum and Chemical Corporation, the Revere Copper and Brass Company, and the Reynolds Metal Company. In addition, the Anaconda Company has a part ownership with two companies in an alumina processing plant. Jamaica has been dealing with the companies one by one on the issue of control. Kaiser depends on Jamaica for two-thirds of its bauxite and was the first company to agree to 51 per cent ownership. Reynolds has also accepted 51 per cent ownership and to an extent so has Revere. The other companies have accepted the principle of government participation but are balking over the percentages. In regard to a higher price for bauxite on the world market, the International Bauxite Association (IBA) is proceeding with its efforts to develop a common pricing formula that would set the price of any given deposit of bauxite ore. The IBA executive board, if all goes as planned, will have the formula ready for the association's Council of Ministers, its policy-making body, to present to the aluminum world in November 1975.

This type of action requiring release of control of vital raw materials makes an alternate source of domestic raw material for the aluminum industry even more necessary.

The "Wall Street Journal" reported on July 10, 1975, that Anaconda Company has filed a lawsuit seeking to uphold a contract for Reynolds Metals Company to sell Anaconda 360,000 tons of alumina in 1977 and 1978 at $70 to $76 a ton. Reynolds informed Anaconda it would have to renegotiate the price due to rising costs. One observer commented that production costs currently range from $100 to $120 a ton. The article further stated that current spot market price for small quantities of alumina is about $135 to $150 a ton.

The prices listed indicate that the production of alumina from kaolin is now competitive with alumina from bauxite.

A proposal was submitted to the Bureau of Industry and Trade, Georgia Department of Community Development for the continuation of the project. The major thrust of the continued program is in the area of responding to current changes and progress in the consideration of kaolin as an ore of aluminum and to continue to assist the Bureau of Industry and Trade in its efforts to implement an alumina from kaolin industry in Georgia. Research will be conducted to provide information required by industry, particularly on environmental considerations and energy requirements.

Assuming the continuation of the project, the plans and objectives of the research team in the coming quarter are to continue to work with industry to assist them in arriving at a positive decision to enter into alumina production from Georgia's kaolin. The research team also will closely monitor the U. S. Bureau of Mines alumina mini-plant project, and use information derived to encourage the producing of alumina from Georgia kaolin. Research will be started to gather information on environmental considerations and energy requirements.

We shall maintain frequent contacts throughout the quarter with the U. S. Bureau of Mines, Washington, College Park, and Boulder City to keep abreast of developments and secure required information.

Assistance to the Bureau of Industry and Trade, Department of Community Development will be continued as required.

Sincerely,

William C. Ward, Jr.
Head, Industrial Services Branch

WCW:lgh

cc: Mr. Ross W. Hammond
Mr. William C. Hawthorne (10)
Dr. John E. Husted
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File A-1458

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ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

October 31, 1975

Georgia Department of Community Development
Trinity-Washington Building
Post Office Box 38097
Atlanta, Georgia 30334

Attention: Mr. James O. Bohanan

Subject: Quarterly Progress Report (No. 13) on Industrial Development Research Project No. A-1458 "Implementation of Alumina from Kaolin Potentials," Period August 1, 1975 - October 31, 1975

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following quarterly progress report is submitted.

The keynote of the twelfth quarter of this project was the continuation of investigations by industry concerning acquisitions and evaluation of kaolin reserves for use as an ore of aluminum, as well as increased interest and activity of both industry and government related to specific actions required to implement the potential development of producing alumina from kaolin. This interest and activity has been manifested by: the continued and expanded operation of the mini-plant research at the U. S. Bureau of Mines, Metallurgy Research Laboratory, Boulder City, Nevada; industry evaluations both technical and economic; the continued research into environmental considerations; and the continued expressed desire of the U. S. Bureau of Mines to work with us on the alumina from kaolin development.

Major events are as follows:

The Steering Committee for the U. S. Bureau of Mines mini-plant operation held its quarterly meeting in Washington, D. C. on August 22, 1975. The U. S. Bureau of Mines submitted its evaluation of the results of the nitric acid process research. Comments from industry representatives indicated that industry considered that enough time has been spent on the nitric acid process for the time being and that the mini-plant should proceed full steam ahead on the testing of the hydrochloric acid process. It was indicated that there will be some changes in the hydrochloric acid process in the late stages which will result in a new flow sheet and possible savings in energy.

Governor Busbee accompanied by representatives of the Georgia Bureau of Industry and Trade visited Pechiney Ugine Kuhlmann in France during a trip to Europe to discuss Pechiney's announced plans for extracting alumina from non-bauxite raw materials, such as clays and shales. Pechiney and Alcan will jointly develop a process utilizing sulphuric and hydrochloric acids called the H-plus process. The two companies are joining forces for construction of a pilot plant in France to test the process.

The 1974 report "Alumina from Kaolin" was entered in the 1975 Literature and Promotion Awards Competition of the Southern Industrial Development Council (SIDC) at the council's annual meeting October 18-21, 1975. The report received "Honorable Mention" award in its category.

We have received some information from the Boulder City Laboratory concerning mini-plant effluents from the nitric acid process. This information is being analyzed and evaluated for use in our environmental considerations.

Representatives from Georgia Bureau of Industry and Trade, Georgia Power Company, Oglethorpe EMC, Trust Company of Georgia, Georgia Chamber of Commerce and the research team met with representatives of two aluminum companies who are actively interested in utilizing kaolin for the production of alumina. The meeting was productive and considerable information was exchanged. The companies provided information which is extremely useful to the project but requested it not be made public at this time.

Research was begun to gather information on environmental considerations for publication in a report. The tentative structure of the report has been established by the research team to include the following chapters.

1. Introduction
2. Mining
3. Processing
4. Energy Conversion
5. Water Supply
6. Water Disposal
7. Ancillary Facilities

Modifications of the above approach may be necessary as the research continues depending on the availability of necessary data. It is planned to discuss the content of the report with the Bureau of Industry and Trade and with the Environmental Protection Division, Georgia Department of Natural Resources as the research effort progresses.

Information has been received from a kaolin company that systematic drilling on a controlled grid pattern indicates that a conservative estimate of dry tons (20% moisture removed) of kaolin on property owned in fee exceeds 100 million tons containing 39.14% alumina. This company has been approached by three aluminum companies to discuss availability of reserves.

On October 8, 1975, Lt. General Louis W. Truman, Commissioner, Georgia Department of Community Development, Mr. James O. Bohanan, Assistant Deputy Commissioner, Mr. Ben Tarbuton, President, Georgia Chamber of Commerce, Mr. Sam Pickering, Director, Earth and Water Division, Georgia Department of Natural

Resources and Dr. John E. Husted of the research team, visited an aluminum company to discuss alumina from kaolin. This company has established an office in Georgia, staffed by two full time geologists and has publicly announced that it has acquired property containing several hundred million tons of clays. This company is extremely interested in developing a domestic alternative to the use of imported bauxite in processing alumina for the production of aluminum. Two major problems exist which inhibit the immediate construction of a commercial plant. They are the capital for new alumina facilities and incentives to help offset the higher per ton investment for an acid process for producing alumina. Considerations, for solution of these problems could be investment credits, low cost loans and other state or federal assistance. The meeting was a fruitful one and contained a free exchange of information and discussion of ways to implement mutual interests of developing a domestic source of alumina.

We received a request from Toth Aluminum Corporation for information on kaolin reserves and availability. A copy of our "Alumina from Kaolin" report and names and addresses of kaolin companies who indicated availability of kaolin in large amounts was sent to Toth Aluminum Corporation in response to their request.

The U. S. Department of Commerce in its publication "U. S. Industrial Outlook, 1975" reported situations which were forecast in our 1972 report "Alumina from Kaolin Potentials." We forecast in 1972 that foreign produced alumina would increase and result in additional aluminum raw material being imported as alumina rather than bauxite and thereby adversely effecting the balance of payments. The U. S. Department of Commerce stated "The effect of the overseas expansion of alumina refining capacity has been evident in the increasing quantities of U. S. imports of alumina." This report also stated "Efforts to develop alternate economically feasible domestic sources of raw materials such as clays, alunite, and anorthosite are increasing, having been given further impetus by the recent Jamaican bauxite levy developments and possible nationalization of foreign bauxite sources."

The U. S. Bureau of Mines, Metallurgy Research Laboratory, Boulder City, Nevada, will conduct a stage testing campaign on the hydrochloric acid process during the period November 16, 1975 to November 21, 1975. The leach, liquid-solid seperation, thickener, and solvent extraction stages will be tested. This campaign will test the process up to the crystallization stage. Later testing of the crystallization, crystal separation and decomposition stages will be made prior to making an integrated circuit campaign on the entire hydrochloric acid process. A member of the research team and a representative from state government may visit the Metallurgy Research Laboratory during the stage testing campaign.

Plans are being made for Lt. General Louis W. Truman, Commissioner, Georgia Department of Community Development, members of his staff, and the research team to meet with Dr. Thomas V. Falkie, Director, U. S. Bureau of Mines, and members of his staff, in early December to continue discussions on the proposed future activities of the Bureau's alumina research and pilot plant development, and how the State of Georgia can give support to this effort. It is planned also for this group to meet with the Washington representative of an aluminum company to discuss the project.

The plans and objectives of the research team in the coming quarter are to continue to work with industry to assist them in arriving at a positive decision to enter into alumina production from Georgia's kaolin. The research team also will closely monitor the U. S. Bureau of Mines alumina mini-plant project, and use information derived to encourage the producing of alumina from kaolin. Research activities by industry outside the cooperative research with the U. S. Bureau of Mines will be closely monitored and information will be furnished these companies as requested. Research will be continued on gathering information on environmental considerations and the writing of the report will be started.

We shall maintain frequent contacts throughout the quarter with the U. S. Bureau of Mines, Washington, College Park, and Boulder City to keep abreast of developments and secure required information.

Assistance to the Bureau of Industry and Trade, Department of Community Development will be continued as required.

Sincerely,

William C. Ward, Jr., Chief
Industrial Services Division

WCW:jes

cc: Mr. Ross W. Hammond
Mr. William C. Hawthorne (10)
Dr. John E. Husted
OCA (2)
File A-1458

A-1458

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

January 30, 1976

Georgia Department of Community Development
Trinity-Washington Building
Post Office Box 38097
Atlanta, Georgia 30334

Attention: Mr. James O. Bohanan

Subject: Quarterly Progress Report (No. 14) on Industrial Development Research Project No. A-1458 "Implementation of Alumina from Kaolin Potentials," Period November 1, 1975 - January 31, 1976

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following quarterly progress report is submitted.

The keynote of the fourteenth quarter of this project was the continuation and expansion of the activity of both industry and government related to specific actions required to implement the potential development of producing alumina from kaolin. This activity has been manifested by: the continued and expanded operation of the mini-plant research at the U. S. Bureau of Mines, Metallurgy Research Laboratory, Boulder City, Nevada; industry suggestions as to future operations; the continued research into environmental considerations; the future plans of the U. S. Bureau of Mines; and the continued expressed desire of the Bureau to work with us on the alumina from kaolin development.

Major events are as follows:

The Steering Committee for the U. S. Bureau of Mines mini-plant operation held its quarterly meeting in Boulder City, Nevada, on November 20, 1975. This meeting was held during a stage testing campaign conducted on the hydrochloric acid process of producing alumina from kaolin at the Metallurgy Research Laboratory during the period November 16-21, 1975. The leach, liquid-solid separation, thickener, and solvent extraction stages were tested. The indications are that everything went very well. The Laboratory personnel were pleased with the mechanical operation of the stages with only minor problems encountered. The Steering Committee had several suggestions for the future direction of the research. These suggestions were incorporated into the U. S. Bureau of Mines future plans which will be included in this report.

On December 5, 1975, Lt. General Louis W. Truman, Commissioner, Georgia Department of Community Development, Mr. James O. Bohanan, Assistant Deputy Commissioner, Mr. H. W. Wiley, Director, Industry Division, and Mr. William C. Ward, Jr. of the research team met with Dr. Thomas V. Falkie, Director,

U. S. Bureau of Mines, Dr. Thomas A. Henrie, Associate Director, Mineral and Materials Research and Development, Mr. R. C. Kirby, Chief, Division of Metallurgy, and Mr. F. A. Peters, Research Supervisor, Process Evaluation to continue discussions on the proposed future activities of the Bureau's alumina research and pilot plant development, and how the State of Georgia can give support to this effort.

Mr. Ralph C. Kirby, Chief, Division of Metallurgy, U. S. Bureau of Mines, gave the group an excellent briefing on the chronology of the alumina project and proposed change in FY 1976 activity on design of pilot plant. This briefing covered past work, history of events which lead to the mini-plant research, actions of bauxite producing countries, formation of the International Bauxite Association (IBA), and industrial cooperation and suggestions for continued research. There are eight original companies cooperating: Alcoa, Alcan, Alumax, Anaconda, Conalco, Kaiser, Martin Marietta, and Reynolds. Two more joined later: Combustion Engineering and Vereinigte Aluminum-Werke. Each company pledged $50,000 per year during the three year cooperative period FY 1975-1977. The Bureau funding was $700,000 for FY 1975 and $730,000 for FY 1976. A Bureau-Industry Steering Committee coordinates the program.

The U. S. Bureau of Mines FY 1976 budget justifications included $2,005,000 "To fix optimum processes and design for pilot plants to recover 50 tons-per-day (TPD) alumina from domestic resources." The Bureau planned to use the money for preparing "Thorough engineering planning and process designs for a 50 TPD plant for each of several technologies."

Industry members of the Steering Committee stated they wished to be a part of the pilot plant effort and made several suggestions. Based on these suggestions, the Bureau proposes to prepare a scope of work for an RFP for cost evaluations for commercial plants (1,000-2,000 TPD) from the point of view of an engineering/construction firm familiar with alumina processing, for six processes, and for the design of a single 50 TPD pilot plant to be selected on the results of these cost evaluations. The six alternative processes are: Clay/HNO_3 (Normal nitrate); Clay/HNO_3 (Basic nitrate); Clay/HCl (Salt recovery by evaporation/crystallization); Clay/HCl (Salt recovery by HCl gas sparging); Clay/H_2SO_3; and Anorthosite (Lime sinter). It can be seen that five of the six processes involve clay (kaolin). This is indicative of the potential of kaolin as a source of alumina. Future plans were also discussed.

The group also met with Mr. William Weingarten, Industrial and Strategic Metals Division, U. S. Department of State to gather information on actions of bauxite producing countries and the International Bauxite Association (IBA). Mr. Weingarten furnished a copy of the Communique of the meeting of the Council of Ministers of the IBA held in Kingston, Jamaica from November 3-7, 1975. A copy of the Communique is attached to this report.

The group next met with Mr. L. Ralph Mecham, Vice-President, The Anaconda Company, and Mr. Robert E. Sullivan, Technical Director-Alumina Operations, Anaconda Aluminum Company, in their Washington, D. C., office. Items discussed were Georgia's actions on alumina from kaolin promotion and Anaconda's current and future plans in regard to alumina from kaolin. Due to Anaconda's financial position at present, no definite plans for the production of alumina from kaolin are being made by Anaconda.

The Bureau of Industry and Trade has suggested that several aluminum company executives be included among the invitees to the Red Carpet tour later in the year. It is believed that this will be a good time to discuss the potential of producing alumina from kaolin and show industry Georgia's resources and desire to be of assistance in the establishment of such an industry.

A member of the research team requested information from an aluminum company relative to technical information about a process the company is considering in order to secure data for environmental considerations. The company declined to furnish the requested information at this time but did indicate that the company is now building a pilot plant to test its version of a process and to provide data for scale-up. The company further stated that to assure that this pilot plant makes provision to study all relevant questions, they have developed a speculative design for a plant to produce one million tons of alumina per year from Georgia clays as would be obtained from their holdings. This indicates that it is only a matter of time before a plant is constructed in Georgia.

Alcan Aluminum Ltd. and a Brazilian iron ore mining company announced, in December 1975, that an agreement in principle has been reached with other participants for the start of construction in January 1976 on a $280 million bauxite project in Brazil. Alcan said the project will be carried out by a Brazilian consortium, in which Brazilian shareholders own 51% with Alcan owning 19%, and other aluminum producers in the United States, Britain, Norway, the Netherlands, and Spain holding the remainder. The initial planned production capacity in 1979 is 3.7 million tons of bauxite a year for export, of which Alcan will receive 1.3 million tons for use in its Canadian facilities. Eventual capacity of more than 8.8 million tons a year is expected.

It is reported that the Southwire Company has started producing alumina from alunite using a Russian-developed process in a pilot facility at the firm's plant in Golden, Colorado.

Revere Copper & Brass Inc. has filed suit in a Jamaican court seeking to have the country's bauxite-production taxes declared invalid. Revere said the action specifically seeks relief from the payment of taxes on bauxite it hasn't mined and alumina it hasn't produced. Although Revere suspended operations at its Jamaican alumina plant last August, it has been required by the bauxite tax law to pay levies as if it were producing alumina at a rate of 190,000 tons a year. The bauxite levy is $14.20 a ton, regardless of the quality of ore, which works out to be $33 a ton of alumina for Revere.

Aluminum Company of America (Alcoa) Chairman W. H. Krome George has stated that 1976 looks like a good year for aluminum. He stated that aluminum shipments in 1976 will be 30-35% higher than during 1975, which would make it the third-highest year in the industry's history. It is expected that aluminum selling prices, currently soft, will firm up as shipments improve. With capital scarce, he says, industry will have to meet increased aluminum demand by expanding, but eventually new plants will have to be built.

Meetings were held with the Commissioner, Department of Natural Resources, Director, Environmental Protection Division, and representatives of the Bureau of Industry and Trade to discuss the "Alumina From Kaolin Environmental Considerations" report. Based on these discussions, the research team has completed a draft of the report. The draft is now in the editing and typing process and will be submitted to the Bureau of Industry and Trade and the Environmental Protection Division for review early in the next quarter.

The Boulder City Laboratory will conduct a fully integrated campaign during the period February 22-27, 1976. This will be the first complete run on the hydrochloric acid process at Boulder City. The Bureau-Industry Steering Committee will meet on February 27, 1976 to discuss the progress of the research.

Dr. John E. Husted of the research team has been notified that his proposal, entitled "Optimum Water Management in Kaolin Mining for Aluminum Production," has been selected for funding the later part of FY 1976. This study will result in a determination of the water use and waste water disposal requirements of alumina from kaolin extraction pilot plants that would operate in Georgia. The end result will be a set of water management recommendations that can be used as a planning tool in support of a potential new alumina industry.

The plans and objectives of the research team in the coming quarter are to continue to work with industry to assist them in arriving at a positive decision to enter into alumina production from Georgia's kaolin. The research team also will closely monitor the U. S. Bureau of Mines alumina mini-plant project and, accompanied by a representative from State Government, will visit the plant to observe the hydrochloric acid campaign in February. The report on environmental considerations will be published during the quarter. Research activities by industry outside the cooperative research with the U. S. Bureau of Mines will be monitored and information will be furnished these companies as requested.

We shall maintain frequent contacts throughout the quarter with the U. S. Bureau of Mines, Washington, College Park, and Boulder City to keep abreast of developments and secure required information.

Assistance to the Bureau of Industry and Trade, Department of Community Development will be continued as required.

Sincerely,

William C. Ward, Jr., Chief
Industrial Services Division

WCW:lag

cc: Mr. Ross W. Hammond
Mr. William C. Hawthorne (10)
Dr. John E. Husted
OCA (2)
File A-1458

COMMUNIQUE OF THE MEETING OF THE
COUNCIL OF MINISTERS OF THE
INTERNATIONAL BAUXITE ASSOCIATION
HELD IN KINGSTON, JAMAICA FROM
NOVEMBER 3 - 7, 1975

The Council of Ministers of the International Bauxite Association held its second session in Kingston, Jamaica, 3 - 7 November, 1975.

Participating at its session were the following Member Countries: Australia, Ghana, Guinea, Guyana, Haiti, Jamaica, Sierra Leone, Surinam and Yugoslavia. A delegation from the Republic of Indonesia attended the session as observer.

The opening address was delivered by the Honourable David Coore, Deputy Prime Minister, on behalf of the Prime Minister of Jamaica the Honourable Michael Manley, who set the tone of the discussions by emphasising that the Third World was not fully satisfied with present developments of the new world economic order and that the bauxite producing countries were entitled to receive a just and equitable price for their bauxite and alumina.

The Council elected as its Chairman, the Honourable Minister of Mining and Natural Resources of Jamaica, Mr. Allan Isaacs. The Honourable Mr. Janko Smole (Yugoslavia), Lt. Col. T.T. Kutin (Ghana) and Drs. Michael Cambridge (Surinam) were elected to the posts of Vice-Chairmen.

One country, the Republic of Indonesia, was admitted to membership. This country will become a full member after its appropriate instrument of accession has been deposited with the Government of Jamaica.

The Council decided that the International Bauxite Association would establish formal and informal relations with a number of international organizations whose interests and objectives are related to those of the I.B.A., particularly organizations of developing countries, which are producers of raw materials.

The Council expressed a special interest of the I.B.A. in the Conference of International Economic Cooperation to be convened in Paris later this year and gave directions that the Association should endeavour to take part, as an observer, in the work of any commission of that conference which is established for raw materials.

The Council gave consideration to the studies carried out on the complex and difficult question of bauxite and alumina valuation, pricing and taxation policies.

The Council decided that the long-term studies on the pricing of bauxite and alumina, and on the valuation and taxation policies which are being carried on by the Secretariat, as directed at the Council's first meeting, should be very actively pursued and gave instructions for an expansion in the scope of the current studies.

Recognising, however, the immediate objective of securing an improvement in each member's income from its bauxite industry in order to contribute to national development, the Council made interim recommendations to members in respect of the pricing of bauxite.

With regards to the short-term policy on the pricing of bauxite, the Council made recommendations for the application by Member Countries of a minimum pricing policy for bauxite exported in 1976.

The Council was assured that Member Countries will use their best endeavours to implement the recommended pricing policy.

The Council approved the selection of a base or standard grade bauxite for the determination of member's bauxite price in the future and approved the basis on which variations in prices would be made to cover differences in quality of ore.

The Council noted with satisfaction the work that the Secretariat had done since the Council's meeting in Guyana last year, and approved the Association's budget for 1976. Provision was made in the budget for strengthening the professional staff of the Secretariat.

It was decided that the next meeting of the Council will be held in Freetown, Sierra Leone.

A-1458

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

April 30, 1976

Georgia Department of Community Development
Trinity-Washington Building
Post Office Box 38097
Atlanta, Georgia 30334

Attention: Mr. James O. Bohanan

Subject: Quarterly Progress Report (No. 15) on Industrial Development Research Project No. A-1458 "Implementation of Alumina from Kaolin Potentials," Period February 1, 1976 - April 30, 1976

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following quarterly progress report is submitted.

The major activities during this quarter of the project were the completion and publication of the "Alumina from Kaolin Enviornmental Considerations" report; the continued and expanded operation of the mini-plant research at the U. S. Bureau of Mines, Metallurgy Research Laboratory, Boulder City, Nevada; the continued interest of industry in implementing the potential development of producing alumina from domestic resources; and the continued expressed desire of the U. S. Bureau of Mines to work with us on the alumina from kaolin development.

Major events are as follows:

Meetings were held with the Director, Environmental Protection Division and representatives of the Bureau of Industry and Trade to discuss the "Alumina from Kaolin Environmental Considerations" draft report. Several constructive suggestions for improvement of the report were received. A major change was the rewriting of the section on land reclamation based on an amendment to the law passed by the General Assembly of Georgia in the 1976 session. Based on these discussions the report was completed and submitted to the Bureau of Industry and Trade and the Environmental Protection Division for review. No changes resulted from this review and the report was published the last week of the quarter. The report contains an alumina from kaolin generalized flow sheet and discusses environmental procedures and environmental considerations for both mining and processing.

A visit was made to the U. S. Bureau of Mines, Metallurgy Research Laboratory, Boulder City, Nevada to observe the testing campaign conducted on the hydrochloric acid process of producing alumina from kaolin during the period February 23-26, 1976. The campaign went very well. The Laboratory personnel were pleased with the mechanical operation of the plant and in particular the environmental control measures installed in the plant. The Steering Committee held its quarterly meeting in Boulder City, Nevada, on February 26, 1976 during the campaign and it is reported the members were satisfied with the results of the campaign and the progress of the program to date. The mini-plant research is proceeding on a fairly rigidly structured schedule. The nitric acid process has essentially been completed and the hydrochloric acid process testing should be completed this year. As a result to the Bureau of Mines/Industry Steering Committee discussions, it has been decided to concentrate on the hydrochloric acid method until completed, to be followed by a sulfurous acid process using kaolin. Upon completion of the sulfurous acid testing, the Bureau of Mines will then proceed with the testing of alumina from anorthosite.

The U. S. Bureau of Mines FY 1976 budget justification included $2,005,000 "To fix optimum processes and design for pilot plants to recover 50 tons-per-day (TPD) alumina from domestic resources." The Bureau planned to use the money for preparing "Thorough engineering planning and process designs for a 50 TPD plant for each of several technologies."

Industry members of the Steering Committee stated they wished to be a part of the pilot plant effort and made several suggestions.

Based on these suggestions, the Bureau of Mines in the February 17, 1976 issue of Commerce Business Daily requested companies interested in doing a preliminary design of a 50 TPD pilot plant, to recover alumina from a domestic nonbauxite resource, to submit their qualifications to the Bureau. Those deemed most qualified will receive a request for proposal (RFP). The process and raw material upon which the pilot plant design will be based will be selected on the basis of cost evaluations to be prepared by the contractor for conceptual commercial-size plants using several promising technologies for treating clay (kaolin) anorthosite, or alunite.

The Bureau of Mines received several replys indicating qualifications and a desire to receive the RFP. To date the Bureau has not issued the RFP but indications are that it will be issued in the near future with a contract award being made prior to the end of this fiscal year.

The Southwire Company has started a pilot plant at Golden, Colorado, for making alumina from alunite, using a Russian process that was purchased under a license agreement. It is considered that this tends to rule out the selection of alunite by the Bureau of Mines and industry.

It also is considered that the use of anorthosite for alumina is many years in the future.

This leaves us with clay (kaolin) as the most viable candidate as a domestic nonbauxite resource. The only choice appears to be which of the several processes utilizing kaolin is the best for large scale pilot plant operation and subsequent commercial size plants. Since Georgia has the largest kaolin reserves in the country, the only logical place for these plants is Georgia.

There is positive indication that this is the belief of industry. Several aluminum companies either own kaolin reserves in Georgia or are actively seeking reserves. Anaconda has done pilot plant research on a hydrochloric acid process using kaolin in the past and Pechiney is currently doing research on kaolin and is reported to be going on stream with a large scale pilot plant later this year. Reynolds is doing pilot plant work on kaolin in its plant in Arkansas. Indications are that the majority of industry desires to concentrate research on kaolin and proceed as rapidly as possible to large scale pilot plant construction and operation.

The research team attended the meeting of the "Forum on the Geology of Industrial Minerals" on April 22-23, 1976. The topic of the meeting was "Industrial Minerals of Georgia and the Southeastern States." Among the papers presented at this meeting was "Alumina from Domestic Resources" by Don H. Baker, Jr., U. S. Bureau of Mines, Boulder City, Nevada. Mr. Baker gave a review of the U. S. Bureau of Mines alumina from kaolin mini-plant program and discussed results to date. Preliminary data indicate that the hydrochloric acid-gas sparging process requires the least amount of energy and is the favored process at present.

The plans and objectives of the research team in the coming quarter are to continue to work with industry to assist them in arriving at a positive decision to enter into alumina production from Georgia's kaolin. The research team also will closely monitor the U. S. Bureau of Mines alumina mini-plant program. The report on enviornmental considerations should be of interest to industry and probably will cause some additional inquires and visible interest of several companies. Research activities by industry outside the cooperative research with the U. S. Bureau of Mines will be monitored and information will be furnished these companies as requested.

We shall maintain frequent contacts throughout the quarter with the U. S. Bureau of Mines, Washington, College Park, and Boulder City to keep abreast of developments.

Assistance to the Bureau of Industry and Trade, Department of Community Development will be continued as required.

Sincerely,

William C. Ward, Jr., Chief
Industrial Services Division

WCW:jes

CC: Mr. Ross W. Hammond
Mr. William C. Hawthorne (10)
Dr. John E. Husted
OCA (2)
File A-1458

A-1458

ENGINEERING EXPERIMENT STATION

GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

July 30, 1976

Georgia Department of Community Development
Trinity-Washington Building
Post Office Box 38097
Atlanta, Georgia 30334

Attention: Mr. James O. Bohanan

Subject: Quarterly Progress Report (No. 16) on Industrial Development Research Project No. A-1458 "Implementation of Alumina from Kaolin Potentials," Period May 1, 1976 - July 31, 1976

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following quarterly progress report is submitted.

The major activities during this quarter of the project were the distribution of the "Alumina from Kaolin Environmental Considerations" report; the continued and expanded operation of the mini-plant research at the U. S. Bureau of Mines, Metallurgy Research Laboratory, Boulder City, Nevada; the continued interest of industry in implementing the potential development of producing alumina from domestic resources; and the continued expressed desire of the U. S. Bureau of Mines to work with us on the alumina from kaolin development.

As indicated in the last quarterly report the U. S. Department of the Interior, Bureau of Mines, issued a Request for Proposals (RFP) No. J0265048, Alumina Process Feasibility Study and Preliminary Pilot Plant Design. This RFP was issued June 3, 1976 with a deadline for receipt of proposals established as July 15, 1976. A pre-proposal conference was held at the Boulder City Metallurgy Research Laboratory, Boulder City, Nevada on June 16, 1976. Representatives from eight companies attended the pre-proposal conference. It is contemplated that all work required will be completed within thirty (30) months after the effective date of contract.

The purpose of the project is to test and develop the most promising technologies in a small-scale pilot plant which would result in economic and technical information necessary for rational decision making for selecting the alumina processing technology that should be developed in a 10 to 50 ton-per-day pilot plant.

The objective of the project is the preliminary design of a 10 to 50 ton-per-day alumina from domestic resources pilot plant.

The work to be accomplished will be performed in three distinct, separate and consecutive tasks.

The objective of Task 1 is to reduce the number of candidate process technologies from six to two. The six process technologies of interest are: clay/nitric acid; clay/hydrochloric acid (salt recovery by evaporation/crystallization); clay/hydrochloric acid (salt recovery by HCL gas sparging); clay/sulfurous acid; anorthosite/lime sinter; and alunite.

Based on a comparison of the advantages and disadvantages of each process, the two most promising processes, from the perspective of a hypothetical industrial operation, will be selected to be analyzed in greater detail in Task 2.

The objective of Task 2 is to develop technical analyses of the two process technologies selected in Task 1 so that a single process technology may be selected which has the greatest potential for supplying alumina from a U. S. resource. The basic size of the plant to be considered in these analyses is one having an output of 1,000 tons of cell-grade alumina per day.

Based on the analyses of the two processes, the Bureau of Mines will select the process to be considered under Task 3.

The objective of Task 3 is to prepare the preliminary design of a 10 to 50 ton-per-day pilot plant using the technology developed in Task 2 to be the most promising from the perspective of an industrial operation.

It is assumed that a contract will be let no later than October 15, 1976, since the RFP requested that proposals be firm for a period of 90 days. If that is the case the time schedule for completion of the various tasks would be: Task 1 - November 1977; Task 2 - March 1978; and Task 3 - April 1979.

The mini-plant research at the U. S. Bureau of Mines, Metallurgy Research Laboratory, Boulder City, Nevada, continued on an expanded scale. Batch leaching tests are being run; thermal decomposition is being tested; equipment for the evaporation crystallization section is being installed; and equipment for the solid liquid separation section is being received. Environmental data are being accumulated from all stage testing. This includes all effluents and their characteristics with emphasis on determination of any possible toxic material. The Boulder City Laboratory is receiving support assistance from other U. S. Bureau of Mines installations in the way of support studies which explore the environmental considerations of all discharges from the system.

As previously reported the mini-plant research is continuing to be concentrated on the hydrochloric acid method until completed. The next fully integrated campaign will probably be conducted at Boulder City, Nevada in October 1976. Stage testing will be continued, in the meantime, in order to test each stage separately prior to the integrated campaign.

In addition to the cooperative work with the U. S. Bureau of Mines, industry is reported to be conducting independent research in the development of alumina from non-bauxite materials.

Independent company programs are reported as follows:

A. Anaconda completed piloting on a 5-7 ton-per-day basis, a HCL process of extracting alumina from kaolin approximately ten years ago. They are reported to have updated their work.

B. Reynolds is piloting an alumina from kaolin project in Arkansas. They have two geologists actively engaged in obtaining reserves of clay in Georgia.

C. Pechiney-Ugine-Kuhlman of France has completed a mini-pilot research program and is reported to be on stream with a large scale pilot. Shale and clays are among materials to be tested. Alcan is participating in the work of Pechiney and reported in its annual report that during 1975 substantial progress was made on the construction of a pilot plant to produce alumina from non-bauxite materials such as clays and shales. This plant, located in Southern France, and the result of many years of research and development by L'Aluminium Pechiney, is being constructed at a cost of some $15 million as a partnership undertaking of Alcan and Pechiney. Alumina production at a trial rate of approximately 7,000 tons per annum is expected to commence in August 1976.

D. Alcoa is reported to have piloted or to be piloting on coal refuse material.

E. Kaiser is reported to be doing considerable research with cost results of alumina being very close to the Bayer-bauxite process. It is understood that Vereinigte Aluminum-Werke AG and Combustion Engineering are cooperating with Kaiser.

The work of the above companies is of course proprietary, but they each require substantial investments and hence show a rather substantial interest in a bauxite substitute. Each of the processes is directed toward clays per se or clay containing sources (shales, coal, refuse, etc.). A process that will successfully and economically get alumina from kaolin in a shale of say 20 or less percent available alumina should be imminently successful on Georgia's kaolins that contain 35 or more percent alumina. Georgia is the world's best source of kaolin.

The plans and objectives of the research team in the coming quarter are to continue to work with industry to assist them in arriving at a positive decision to enter into alumina production from Georgia's kaolin. The research team also will closely monitor the U. S. Bureau of Mines alumina mini-plant program. The report on environmental considerations should be of interest to industry and probably will cause some additional inquires and visible interest of several companies. Research activities by industry outside the cooperative research with the U. S. Bureau of Mines will be monitored and information will be furnished these companies as requested.

We shall maintain frequent contacts throughout the quarter with the U. S. Bureau of Mines, Washington, College Park, and Boulder City to keep abreast of developments.

Assistance to the Bureau of Industry and Trade, Department of Community Development will be continued as required. Detailed plans for the program for the coming year will be developed with the Bureau of Industry and Trade during August 1976.

Sincerely,

William C. Ward, Jr., Chief
Industrial Development Division

WCW:jes

cc: Mr. Ross W. Hammond
Mr. William C. Hawthorne (5)
Dr. John E. Husted
OCA (2)
File A-1458

A-1458

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

October 29, 1976

Georgia Department of Community Development
Trinity-Washington Building
Post Office Box 38097
Atlanta, Georgia 30334

Attention: Mr. James O. Bohanan

Subject: Quarterly Progress Report (No. 17) on Industrial Development Research Project No. A-1458 "Implementation of Alumina from Kaolin Potentials," Period August 1, 1976 - October 31, 1976

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following quarterly progress report is submitted.

The major activities during this quarter of the project were the gathering of information for this year's report; the continued and expanded operation of the mini-plant research by the U. S. Bureau of Mines; the personnel changes in the direction and management of the alumina research program of the U. S. Bureau of Mines; the continued action of Jamaica in acquiring majority interest in mining operation of U. S. companies in Jamaica; the letting of a contract by the U. S. Bureau of Mines for an Alumina Process Feasibility Study and Preliminary Pilot Plant Design; the continued interest of industry in implementing the potential development of producing alumina from domestic resources; and the continued expressed desire of the U. S. Bureau of Mines to work with us on the alumina from kaolin development.

As a part of the research to gather information to be included in the report, contacts were made, during the quarter, with each of the major aluminum companies known to be individually active with in-house alumina from kaolin research. Much of the desired information may be available during the first quarter of 1977.

The research team met with a representative of the Georgia Bureau of Industry and Trade to discuss the project in general, and broad areas to be included in the report. The content of the proposed amendment to the Georgia Constitution pertaining to actions to be taken by Jefferson County in the event an alumina from kaolin plant is established in that county was also reviewed.

A member of the research team accompanied a representative of the Georgia Bureau of Industry and Trade to Louisville, Georgia to discuss alumina from kaolin with citizens of the area.

The research team has begun gathering information on five potential sites for production of alumina. As the information is refined and analyzed, the most likely general locations for a commercial alumina from kaolin plant will appear. This information will be included in the report to be issued later in the contract year.

The nitric acid mini-plant research program is essentially completed with all data generated at Boulder City now in the hands of Process Evaluation, U. S. Bureau of Mines, College Park, Maryland. The nitric acid plant is being retained but in a shutdown condition.

The hydrochloric acid process is still in the stage testing status with intermittant testing being carried out about two days per week at Boulder City, Nevada. Batch type runs are being made on the leach; thickener; solid-liquid separation; and decomposition stages. The evaporation crystallization equipment is being installed and the gas sparging equipment is on order with expected delivery and installation by December 1976. There will probably be a fully integrated campaign run of the hydrochloric acid process early in 1977.

The equipment for the anorthosite process is being received at Boulder City and will be installed in Building 600 (separate from the nitric and hydrochloric plants) at Boulder City over the next six to nine months. Testing of this process is to be started after the completion of the hydrochloric acid process research.

The quarterly Government/Industry Steering Committee Meeting was held on August 26, 1976. The status of the research program was presented and discussed as well as plans for the next quarter. The next meeting will be held at the Reno Metallurgy Research Center in November 1976.

There has been considerable change in the personnel who have been involved with the mini-plant research at Boulder City, Nevada as well as changes in management direction and names of facilities. Don Kesterke who was Chief, Boulder City Metallurgy Research Laboratory, has been reassigned to Washington, D. C., and has been replaced by Howard O. Poppleton. The Boulder City facility has been renamed the Boulder City Metallurgy Engineering Laboratory with Howard O. Poppleton as Chief. Don Baker who was supervising the mini-plant operation at Boulder City has been reassigned and replaced by Dwight Sawyer.

Frank Block is Director, Reno Metallurgy Research Center and has overall responsibility for the activities of the Boulder City Laboratory which reports to him. Gerald McSweeny at the Reno Research Center is Program Manager for alumina for the U. S. Bureau of Mines and reports to Frank Block. This means that the direction of the aluminum from non-bauxite ores has been shifted from Boulder City to Reno with the operational aspects being retained at Boulder City.

The contract for the analysis of various processes of producing alumina from non-bauxite ores, the selection of a single process technology and design of a 10 to 50 ton-per-day pilot plant was let to Kaiser Aluminum and Chemical Corporation.

The study will be divided into three tasks. The objective of Task 1 is to reduce the number of candidate process technologies from six to two. The six process technologies to be examined are:

- o Clay/nitric acid
- o Clay/hydrochloric acid (salt recovery by evaporation/crystallization)
- o Clay/hydrochloric acid (salt recovery by HCl gas sparging)
- o Clay/sulfurous acid
- o Anorthosite/lime sinter
- o Alunite

It is interesting to note that four of the six processes involve clay (kaolin) which would indicate strongly that a clay process will be one of the two selected. In addition, since there is extensive pilot plant research being done on alunite at the present time, by private industry, it would appear that this would tend to eliminate alunite from being one of the two to be selected. It is believed that the two processes selected for final analysis will utilize clay (kaolin).

A contact was made with Kaiser Aluminum and Chemical Corporation relative to their contract. It was learned that the contract stipulates that no information developed by the study can be released until a published report is released. We offered any assistance they may need and at their request, forwarded three copies of the "Alumina from Kaolin Environmental Considerations" report.

It was reported in the July 1976, issue of the Engineering Mining Journal that the world's first commercial facility to utilize the power-saving Alcoa smelting process for the production of aluminum was recently started up in Palestine, Texas. The cells of the process use 30% less power than potlines and have the additional advantage of being free of flouride emissions. The first-phase operation is to produce 15,000 tons-per-year (tpy). The plant's ultimate design capacity is 300,000 tpy of primary aluminum.

The patented Alcoa smelting process is an electrolytic method which, like the Hall process, uses alumina as its fuel. The alumina is combined with chlorine in a reactor unit, which chemically converts the aluminum oxide to aluminum chloride. The chloride is then processed electrolytically in an enclosed cell which separates the compound into molten aluminum and chlorine. The chlorine is continuously recycled to the reactor in a closed-loop operation.

Since this process uses alumina and 30% less power, it would appear that alumina from kaolin could be used by this process to produce aluminum in Georgia at a competitive price.

The transfer of land holdings and 51% of Jamaican mining assets from U. S. aluminum companies to the Jamaican government continues. Aluminum Company of America (Alcoa) has agreed to sell to the Jamaican government all of its mining and nonoperating lands there and a 6% interest in its bauxite mining and refining operations in Jamaica. It was agreed that a 6% share of Alcoa's mining and refining assets would reflect adequately the value of 51% of Alcoa's mining assets. This is in accordance with Jamaica's announced intentions of acquiring 51% of all bauxite mining assets owned by private companies in Jamaica. In earlier agreements Reynolds Metals Company and Kaiser Aluminum and Chemical Corporation agreed to sell their land holdings and 51% of their Jamaican mining assets to the government. In return, the agreements provide that Jamaica will lower its levy on bauxite produced there to 7.5% from 8% of the realized price of primary aluminum in the U. S.

The International Bauxite Association (IBA) is still seeking a common pricing formula for all 11 member nations. IBA's secretary-general stated that "establishment of a viable, long-term pricing policy requires considerable study and cannot be achieved overnight. This is not generally recognized." The third annual meeting of IBA's top ministers has been set for November 1976, in Sierra Leone.

A contact was made by Mr. Gerald McSweeny of the U. S. Bureau of Mines at Reno, Nevada to determine the basis for the grade (percentage Al_2O_3) assigned to Georgia clay reserves in our previous report. The clay they are using at Boulder City, Nevada is somewhat higher than what we used and one of the cooperating aluminum companies had called their attention to this. Our report, using 33% Al_2O_3, was based on total reserves, non-selective mining, and the known presence of quartz-sand stringers that would lower overall grade as opposed to selective mining of high grade pure clay for the pilot plant. This information was given to Mr. McSweeny.

The plans and objectives of the research team in the coming quarter are to continue to work with industry to assist them in arriving at a positive decision to enter into alumina production from Georgia's kaolin. Personal contacts by visits to at least four companies are planned for the next quarter. The research team also will closely monitor the U. S. Bureau of Mines alumina mini-plant program. Visits are planned to the Reno Metallurgy Research Center and the Boulder City Metallurgy Engineering Laboratory to establish the same close personal working relationship with the new management as was enjoyed with the prior management.

We shall maintain frequent contacts throughout the quarter with the U. S. Bureau of Mines, Washington, College Park, Reno, and Boulder City to keep abreast of developments. The progress of Kaiser Aluminum and Chemical Corporation work under contract to the U. S. Bureau of Mines will be monitored. Information from their study will be reviewed and analyzed as it becomes available.

Information will continue to be gathered for the report to be published during the contract year. Assistance to the Bureau of Industry and Trade, Department of Community Development will be continued as required.

Sincerely,

William C. Ward, Jr., Chief
Industrial Development Division

cc: Mr. Ross W. Hammond
Mr. William C. Hawthorne (5)
Mr. John Overstreet
Dr. John E. Husted
OCA (2)
File A-1458

A-1458

ENGINEERING EXPERIMENT STATION

GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

January 31, 1977

Georgia Bureau of Industry and Trade
1400 Omni International North
P.O. Box 1776
Atlanta, GA 30301

Attention: Mr. James O. Bohanan

Subject: Quarterly Progress Report (No. ~~15~~ 18) on Industrial Development Research Project No. A-1458 "Implementation of Alumina from Kaolin Potentials," Period November 1, 1976 - January 31, 1977

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following quarterly progress report is submitted.

The major activities during this quarter of the project were the gathering of information for this year's report; the continued operation of the mini-plant research by the U.S. Bureau of Mines; the beginning of work on the U.S. Bureau of Mines contract for an Alumina Process Feasibility Study and Pilot Plant Design; the continual interest of industry in implementing the potential development of producing alumina from domestic resources; and the continued expressed desire of industry and the U.S. Bureau of Mines to work with us on the alumina from kaolin development.

As a part of the research to gather information to be included in the report, contacts were made, during the quarter, with several aluminum companies and with potential supplies of energy and other raw materials. Information on potential sites, water and transportation was also gathered.

The research team, accompanied by a representative of State Government, visited, during January, the U.S. Bureau of Mines Metallurgy Engineering Laboratory, Boulder City, Nevada, the U.S. Bureau of Mines Metallurgy Research Center, Reno, Nevada, Kaiser Aluminum and Chemical Corporation, Oakland, California, Kaiser Center for Technology, Pleasanton, California, and Alumax, Inc., San Mateo, California. The purpose of these visits was to gather information for the report and to determine the status of research by the U.S. Bureau of Mines and Industry.

Major changes have been made in the mini-plant facilities at Boulder City, Nevada as a result of the management and direction changes by the U.S. Bureau of Mines. The nitric acid mini-plant has been dismantled to make additional room for an expanded hydrochloric acid mini-plant. Batch type runs are being made on the various stages of the process. Additional equipment is on hand for installation and additional equipment is on order. It appears that the present plans are to continue with stage testing at Boulder City with some support analysis to be performed by other U.S. Bureau of Mines facilities. It also appears that no fully integrated run is planned on the hydrochloric acid process at Boulder City in the near future. The U.S. Bureau of Mines is looking to the Kaiser Engineers contract to give them answers to many of the questions that would have been addressed at Boulder City.

The next quarterly meeting of the Government/Industry Steering Committee will be held in Atlanta, Georgia March 11, 1977 in conjunction with the AIME Annual Meeting March 6 - 10, 1977. As a part of the AIME meeting, there will be a Field Trip to the kaolin belt of Georgia which, from all indications, will be well attended by the aluminum industry representatives.

The U.S. Bureau of Mines issued a press release announcing the award of the contract for "Alumina Process Evaluation and Pilot Plant Design." The $1,581,571 award went to Kaiser Engineers, a division of Kaiser Industries Corporation.

Kaiser Engineers will make technical appraisals of six experimental techniques for extracting alumina from abundant domestic clays or other aluminum-bearing resources that cannot presently be processed economically. Small-scale "mini-plant" tests of the six processes are currently being co-sponsored by the Bureau and nine firms involved with alumina technology to obtain some of the economic and technical data needed to determine their economic potential. (The nine firms are: Aluminum Company of America, Aluminum Company of Canada, Ltd., Alumax, Inc., Anaconda Company, Combustion Engineering, Inc., Conalco, Inc., Kaiser Aluminum and Chemical Corp., Reynolds Metals Company, and Vereinigte Aluminum-Werke Ag.)

In the first phase of the contract, Kaiser Engineers will use data from the mini-plant tests and other sources to evaluate the six alumina recovery processes and, on the basis of that evaluation, the Bureau will pick the two with the most promising potential. After further evaluation in the second phase of the contract, the Bureau will choose the better of the two. Kaiser Engineers then will complete the contract by designing a pilot plant capable of producing between 10 and 50 tons of alumina each day, based on the process chosen by the Bureau.

Selection of alumina recovery technology and design of the pilot plant will take into account energy consumption, and also potential environmental pollution problems so that methods for controlling them will be in compliance with Federal, State and local laws. Data from operation of the pilot plant will be used in determining whether the process is promising enough to be scaled-up to a commercial size plant.

Kaiser Engineers has sub-contracted with Kaiser Aluminum and Chemical Corporation for much of the work to be done under Phase 1 of the contract.

While Kaiser Aluminum and Chemical Corporation could not give us any information developed since the start of the contract, they did give us considerable information based on research done by them prior to the award of the contract. This information, relative to plant needs for alumina from clay (kaolin), included requirements for clay, acid, energy, water, personnel and capital.

In addition, we discussed possible time schedules for completion of the project to the building of a commercial alumina from kaolin plant under normal procedures and under a crash program. These schedules are as follows starting with January, 1977.

Activity	Normal Time and Completion		Crash Program Time and Completion	
Feasibility Study	27 mos.	5/79	6 mos.	7/77
Design & Build Pilot Plant	30 mos.	11/81	24 mos.	7/79
Operate Pilot Plant	18 mos.	5/83	12 mos.	7/80
Refine Process & Costs	6 mos.	11/83	6 mos.	1/81
Design & Build Comm. Plant	40 mos.	5/87	40 mos.	7/84

From the above we can see that the time frame for a 10-50 ton-per-day pilot plant is in the 1980-83 range and for a commercial size plant in the 1984-87 range.

Kaiser Aluminum and Chemical Corporation stated that we could be of assistance to them by providing certain important cost information on delivered cost of clay and coal and transportation of alumina to reduction plants. We expect to have most of this information in our report.

The research team, representatives of the Georgia Bureau of Industry and Trade, and a representative of the Georgia Environmental Protection Division met with a representative of an aluminum company to discuss various problem areas of interest to this company in its decision making process on whether or not to enter into production of alumina from kaolin. These major areas are mining, water, waste disposal, raw materials, utilities, transportation and manpower. Some information was furnished and more information will be furnished.

It has been reported that Reynolds Metals Company and Alcoa of Australia, Ltd., an affiliate of Aluminum Company of America, have agreed to establish an alumina refinery in Western Australia at a cost of more than $650 million. The refinery will have an initial capacity of between 800,000 and one million tons of alumina a year. The plant is to be built at Wagerup, south of Perth, in Western Australia.

The merger of The Anaconda Company with Atlantic Richfield has been completed. This should result in the merged company taking another look at its interest in an alumina from kaolin program.

The plans and objectives of the research team in the coming quarter are to complete the gathering of information for the report to be published during the contract year and to continue to work with industry to assist them in arriving at a positive discussion to enter into alumina production from Georgia's kaolin. The major items to be addressed in the report included site criteria and site choices, potential methods of extraction of alumina from kaolin, estimated costs for each method, and availability of raw materials, utilities, water, transportation and manpower.

The research team also will monitor the U.S. Bureau of Mines alumina mini-plant program and the progress on the contract with Kaiser Engineers. We shall maintain frequent contacts throughout the quarter with the U.S. Bureau of Mines and interested aluminum companies.

Assistance to the Bureau of Industry and Trade will be continued as required.

Sincerely,

William C. Ward, Jr., Chief
Industrial Development Division

kb
cc: Mr. Ross W. Hammond
Mr. William C. Hawthorne (5)
Mr. John Overstreet
Dr. John E. Husted
OCA (2)
File A-1458

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

August 1, 1977

Georgia Department of Industry and Trade
1400 Omni International North
P. O. Box 1776
Atlanta, Georgia 30301

Attention: Mr. James O. Bohanan

Subject: Quarterly Progress Report (No. 20) on Industrial Development Research Project No. A-1458 "Implementation of Alumina from Kaolin Potentials," Period May 1, 1977 - July 31, 1977

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following quarterly progress report is submitted.

The publication of *Alumina from Kaolin II* report in June completed the major thrust of the current contract. There were three objectives of this report. The first was to update information on the technology and economics of securing alumina from kaolin. The second objective was to present a timetable showing the near-future potential of an alumina-from-kaolin facility in Georgia. Based on the potential of such a facility, the third objective was to identify potential sites for consideration in terms of the various parameters that may be used by industries for their choice in the location of alumina-from-kaolin plants.

Three processes for the extraction of alumina-from-kaolin were addressed. Based on an assumption of optimum technology, the same thermal energy requirements for each process, an output of one million short tons per year, and $600 million in capital investment, the cost per net short ton of alumina was estimated for the three most promising alumina-from-kaolin processes as follows:

Hydrochloric Acid Process	-	$137.89
H + (Pechiney Alcan) Process	-	139.81
Nitric Acid Process	-	142.35

It was projected that the first alumina-from-kaolin facilities will be established in Georgia between 1980 and 1985, and that these facilities will achieve an output of one million tons annually between 1988 and 1993.

The following four potential site areas were identified, based on the availability of a sufficient quantity of an appropriate quality of kaolin, the availability of adequate water to operate an alumina-from-kaolin process, the presence of transportation facilities, and a consideration of the impact of the plant on the environment of the area:

1. Wrens area -- portions of Jefferson, Glascock, and Warren counties and possibly some of McDuffie County.
2. Sandersville area -- all of Washington County.
3. McIntyre area -- portions of Twiggs and Wilkinson counties and possibly some of Baldwin County.
4. Andersonville area -- portions of Sumter and Schley counties.

There was an extensive article by Jenny Munro published in the Augusta, Georgia, *Sunday Chronicle-Herald* on July 10, 1977, on alumina-from-kaolin.

A new time schedule for the U. S. Bureau of Mines contract with Kaiser Engineers for "Alumina Process Feasibility Study and Preliminary Pilot Plant Design" has been issued as follows:

TIME SCHEDULE FOR CONTRACT J0265048
"Alumina Process Feasibility Study and Preliminary Pilot Plant Design"

October 1, 1976	Start Task 1 (Selection of two processes)
September 30, 1977	Draft report on Task 1 due
October 10, 1977	Oral presentation on Task 1
October 20, 1977	Bureau revisions to report due
November 9, 1977	Final report due. Bureau notifies contractor to proceed with Task 2.
February 9, 1978	Draft report on Task 2 due (Selection of best process)
February 19, 1978	Oral presentation on Task 2
March 1, 1978	Bureau revisions to report due
March 21, 1978	Final report due. Bureau notifies contractor to proceed with Task 3.
September 21, 1978	Preliminary cost estimate of pilot plant due
March 21, 1979	Draft report on Task 3 due
March 31, 1979	Oral presentation on Task 3
April 10, 1979	Bureau revisions to report due
April 30, 1979	Final report due (Preliminary Pilot Plant Design)

Contacts were made with members of the primary aluminum industry concerning their interest in giving papers at a symposium on the production of alumina from non-bauxitic ores which was proposed by the U. S.-U.S.S.R. Trade and Economic Council with Georgia Tech participation. This is still in the planning stage and if conducted will be held in Atlanta in November or December.

A major problem related to an alumina-from-kaolin pilot facility in Georgia is the threatened fragmentation of the U. S. Bureau of Mines which severely curtails their ability to be a positive force, particularly in the budgeting process required to secure the commitment of funds for the large-scale pilot plant.

The plans and objectives of the research team in the coming quarter are to continue to monitor the U. S. Bureau of Mines alumina mini-plant program and the progress on the overall program. Contacts will be maintained with the U. S. Bureau of Mines and interested aluminum companies.

Assistance to the Department of Industry and Trade will be continued as required.

Sincerely,

William C. Ward, Jr.
Associate Director
Technology and Development Laboratory

mpc

cc: Mr. William C. Hawthorne (5)
Mr. John Overstreet
Dr. John E. Husted
OCA (2)
File A-1458

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

November 1, 1977

Georgia Department of Industry and Trade
1400 Omni International North
P. O. Box 1776
Atlanta, Georgia 30301

Attention: Mr. James O. Bohanan

Subject: Quarterly Progress Report (No. 21) on Industrial Development Research Project No. A-1458, "Implementation of Alumina from Kaolin Potentials," Period August 1, 1977-October 31, 1977

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following quarterly progress report is submitted.

The present agreement was continued for an additional three-month period commencing on August 1, 1977, and extending through October 31, 1977, for the purpose of maintaining continuity pending funding for an additional 12 months. A proposal for continuation of this research project was submitted to you on September 9, 1977.

As was reported in the last quarterly report, the publication of Alumina from Kaolin II report completed the major thrust of the current contract. Several requests have been received for additional copies of this report and it appears to be well received by industry.

Activity during the present quarter was mainly the monitoring of the U. S. Bureau of Mines alumina pilot plant program and the progress of the overall alumina from kaolin research program.

The time schedule for the U. S. Bureau of Mines contract with Kaiser Engineers for "Alumina Process Feasibility Study and Preliminary Pilot Plant Design," which was set forth in the last quarterly report, indicated that an oral presentation on findings under Task 1 was to be made on October 10, 1977.

It is our understanding that a preliminary oral report has been made by Kaiser concerning the first phase of this work, but information will not be made available until review and approval by the U. S. Bureau of Mines. A date for this is uncertain at this time.

We also have received information that Alcoa and Conalco have withdrawn from the joint government/industry cooperative research program.

The major need at present is to get the large-scale pilot plant program funded and under way. It is reported that an industry decision will be made by

November 1977 concerning industry participation in a 10-50 ton-per-day of alumina pilot facility to make Al_2O_3 from kaolin. It is believed that if industry participates the government portion of the necessary funding will be budgeted.

During the current quarter an article entitled, "An Integrated Aluminum Industry for the Southeast," by Dr. John E. Husted, was published in the September 1977 issue of the Mining Congress Journal. The article reviewed the effort made in Georgia for an alumina from kaolin industry, estimated present costs, and projected an integrated aluminum industry in Georgia by the mid 1990's.

Since this quarter is the final quarter under the present agreement, the plans and objectives of the research team for the future are dependent on the action taken by the Department of Industry and Trade on the proposal submitted September 9, 1977 for continuation of this research project for an additional 12 months.

Assuming that the agreement will be extended, we plan to meet with you at an early date to establish a schedule of work for the coming year.

Sincerely,

William C. Ward, Jr.
Associate Director
Technology and Development Laboratory

mpc

cc: Mr. William C. Hawthorne (5)
Mr. John Overstreet
Dr. John E. Husted
OCA (2)
File A-1458

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

January 31, 1978

Georgia Department of Industry and Trade
1400 Omni International North
P. O. Box 1776
Atlanta, Georgia 30301

Attention: Mr. James O. Bohanan

Subject: Quarterly Progress Report (No. 22) on Industrial Development Research, Project No. A-1458, "Implementation of Alumina from Kaolin Potentials," Period November 1, 1977-January 31, 1978

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following quarterly progress report is submitted.

The present agreement was continued for an additional twelve-month period commencing on November 1, 1977, and extending through October 31, 1978.

The research team met with a representative of the Georgia Department of Industry and Trade in November to discuss the program of work for the coming year and the status of the project in general.

The article, "An Integrated Aluminum Industry for the Southeast," by Dr. John E. Husted which was published in the September 1977 issue of the Mining Congress Journal has generated favorable comment and additional requests for copies of the Alumina from Kaolin II report. Of interest is a request from AMAX, Inc., the parent company of Alumax, Inc.

An article entitled, "Changing Realities in the Aluminum Industry," by A. S. Hutchcraft, Vice President and General Manager, Raw Materials and Reduction Division, Kaiser Aluminum and Chemical Corp., was published in the November 1977 issue of the Mining Congress Journal. In this article Mr. Hutchcraft indicated that preliminary estimates indicate that alumina can be produced from domestic clays at costs that are comparable to those of alumina produced from Caribbean bauxite, at today's prices including levies and processed in new Bayer plants.

The period November 1, 1977, through January 31, 1978, has been one of uncertainty concerning alumina from kaolin.

The uncertainty originates in a lack of knowledge concerning the intent of both industry and government concerning the pilot stage of the industry-government cooperative work.

Financing of the pilot plant has been projected on the same basis as other cooperative work concerning the alumina from non-bauxite sources effort. This has posed the problem of (1) Was the government budgeting for their share of the pilot? and (2) Were there enough industry members interested in supporting industries' share of costs?

Task II of the Kaiser contract has been completed and it is our understanding that a hydrochloric acid extraction method using a hydrogen chloride gas sparging method for crystallization of the resulting aluminum chloride was recommended as the most commercial of the six processes studied for production of alumina from non-bauxite sources. Total estimated cost of the pilot is on an order of 60 million dollars.

The U. S. Bureau of Mines did not request the government's share of the pilot in their budget. It is reported that this was because it would have about doubled the metallurgy budget, and hence, if the pilot was mandated without the increase in funds, the metallurgy program would have been severely curtailed. Funds are reported to be recommended through the Office of Emergency Preparedness of the General Services Administration. At this writing, it is not known whether this item is approved by the Office of Management and Budget or not. It is known that OMB is interested in the program as evidenced by a request for information by Mr. James T. McIntyre, Acting Director of OMB, on the project. A copy of the information forwarded to Mr. McIntyre by John Overstreet, Georgia Office of Planning and Budget, is attached.

On industry's side, at this writing, four companies were considered needed for an equitable division of costs. Only three have so far agreed to participate; namely, Kaiser, Reynolds, and Anaconda.

In the meanwhile, the currently budgeted work of the mini-pilot at Boulder City, Nevada, is proceeding. Attention will be directed toward the solid separation of the process following leaching to generate pregnant liquor for sparging. The crystallization equipment is in place and in a start-up condition. Testing will begin by late February and continue through most if not all of March. Specific areas of investigation are for trace elements such as phosphorous and potassium and the extent they are in the liquor and to the extent they are found in the formed crystals of aluminum chloride hexahydrate. Alumina has a specification maximum of 0.001 percent phosphorous, as an example.

As indicated above, the Georgia Tech effort has been directed toward monitoring the efforts of industry and government and being of assistance where possible. As part of this effort, close cooperation has been maintained with the Georgia Department of Industry and Trade.

The plans and objectives of the research team in the coming quarter are to continue to monitor the U. S. Bureau of Mines alumina mini-plant program and the progress on the overall program. Contacts will be maintained with the U. S. Bureau of Mines and interested aluminum companies. The Government/Industry Steering Committee will meet in March 1978. It is planned to visit the mini-plant in March to discuss the results of the testing and the items reported to the Steering Committee.

Assistance to the Department of Industry and Trade will be continued as required.

Sincerely,

William C. Ward, Jr.
Associate Director
Technology and Development Laboratory

cc Mr. William C. Hawthorne (5)
Mr. John Overstreet
Dr. John E. Husted
OCA (2)
File A-1458

SUMMARY:
Georgia Tech's Alumina from Kaolin Efforts

The thrust of the research conducted by the Georgia Institute of Technology under contract to the Georgia Department of Industry and Trade has been toward the realization of the potential of an alumina industry in Georgia. The contract has been funded since its initiation by the Coastal Plains Regional Commission.

A pilot plant in Georgia for the production of alumina from kaolin is essential to full alumina production facilities. The production of alumina from this very important domestic source will be of large economic and strategic benefit to the nation. This will be true in off-setting balance-of-payments, an improved national defense posture, an improved tax base, improved southeast employment, improved negotiating base with bauxite countries, and improved strategic logistics. Because of the above mentioned items and because approximately 90 percent of our aluminum is imported in part from potentially unreliable sources, because of the importance of aluminum in lowering energy requirements in transportation, because of the importance of aluminum to our total industrial economy, because of the lead time required for Georgia' domestic source of aluminum to be realized, we therefore urge the Office of Management and Budget to implement an adequate budget to support a pilot program of making alumina from kaolin in Georgia.

The work contract for this program with Georgia Tech has produced the following publications.

1. "Alumina from Kaolin Potentials" - 1972.

   This report established the technical and economic feasibility of producing alumina from kaolin and brought Georgia's extensive (over 3.5 billion short tons) kaolin reserves to the attention of the aluminum industry. It also pointed to problems of nationalism in producing countries and to problems of strategic logistics. It recommended a pilot by the U.S. Bureau of Mines.

2. "Alumina from Kaolin" - 1974.

This report called attention to the 180 degree change in attitude of the aluminum industry since 1972 and the U.S. Bureau of Mines-Industry mini-pilot plant program started in 1973. In addition, it summarized available kaolin reserves in Georgia as well as state-of-the-art technology and economics.

3. "Alumina from Kaolin Environmental Considerations" - 1976.

This publication abstracted the environmental laws and regulations of the State of Georgia and related them to a potential alumina from kaolin facility.

4. "Alumina from Kaolin--II" - 1977.

This report updated information on the advancing technology and economics of obtaining alumina from kaolin and gave a timetable of an alumina from kaolin facility in Georgia. In addition it identified several potential sites for such an industry.

In order to enhance the program and call attention to the potential of Georgia's aluminum ores, Dr. John E. Husted of Georgia Tech and a Co-Principal Investigator of the Project has published or presented papers as follows:

1. "Potential Reserves of Domestic Non-Bauxite Sources of Aluminum," presented at The Metal Society, AIME, annual meeting, 1974. Information was based on a study made for the U.S. Bureau of Mines' MAS program.
2. "An Integrated Aluminum Industry for Georgia--Concerns and Outlook," presented to The Metal Society of AIME, Annual Meeting (Atlanta), March, 1977. Costs and a potential timetable were given.
3. "An Integrated Aluminum Industry for the Southeast--Concerns and Outlook," Mining Congress Journal, September 1977, pp. 28-33. This article was a publication of the paper in item 2 above and puts in perspective the expected realization of an integrated aluminum industry in Georgia based

on Georgia's reserves of kaolin. A copy is attached.

4. "Kaolin--A Potential Ore of Aluminum," presented at Fall Meeting of The Society of Mining Engineers, AIME, October 20, 1977.

Dr. Husted also has an ongoing project with the Office of Water Resources and Technology, U.S. Department of the Interior, entitled, "Optimum Water Management for an Alumina from Kaolin Facility." This project is nearing completion and will provide water management guidance when an alumina facility is built in Georgia.

Continuous and up-to-date liaison is maintained by Georgia Tech with the U.S. Bureau of Mines' mini-pilot facility, the aluminum industry, and the Georgia Department of Industry and Trade. The program's priority is the establishment of an alumina-aluminum industry in Georgia based on Georgia's kaolin reserves. An alumina from kaolin pilot in Georgia is the ongoing priority.

A-1458

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

April 28, 1978

Georgia Department of Industry and Trade
1400 Omni International North
P. O. Box 1776
Atlanta, Georgia 30301

Attention: Mr. James O. Bohanan

Subject: Quarterly Progress Report (No. 23) on Industrial Development Research, Project No. A-1458, "Implementation of Alumina from Kaolin Potentials," Period February 1-April 30, 1978

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following quarterly progress report is submitted.

The U. S. Bureau of Mines operated the clay/hydrochloric acid miniplant at the Boulder City Metallurgy Engineering Laboratory during the period March 7-16, 1978. The process was operated through the acid leaching, solid/liquid separation and pregnant liquor filtration steps. Other operations, such as the removal of iron from the polished pregnant liquor by means of solvent extraction, liquor concentration by evaporation, and crystallization of $AlCl_3 \cdot 6H_2O$ by means of HCl gas induced crystallization in a continuous crystallizer, was left for a later date.

The research team, accompanied by the state Program Manager, Coastal Plains Regional Commission, visited the Boulder City Metallurgy Engineering Laboratory to observe the operation of the miniplant the week of March 13, 1978.

Calcined Georgia kaolin was fed into a leaching tank containing hydrochloric acid and the product of the leach vessels was fed through a series of spiral classifiers to separate the silica residue from the pregnant liquor. The pregnant liquor was polished to remove sediment and the clear polished pregnant liquor was stored for use in the crystallization work to be done later.

The crystallization equipment was in place. According to Dr. Kermit Bengston of Kaiser Aluminum and Chemical Corporation, the clorine gas sparging unit is the largest in the world. Work on use of this equipment should now be in progress.

The capacity of the minipilot has risen from a few pounds to approximately 3 tons per day of feed (250 pounds per hour).

In addition to observing the ongoing research, meetings were held with representatives of Kaiser Aluminum and Chemical Corporation, Kaiser Engineers, and the General Accounting Office.

The Kaiser representatives were also present for the miniplant demonstration. Needed work was discussed, particularly the need for a better characterization of kaolin from Georgia as an ore of aluminum. As a result of this discussion and request, Dr. Husted is proposing a classification of Georgia's kaolin as an ore of aluminum to the U. S. Bureau of Mines. Agreement of kaolin producers has been obtained for them to furnish samples. Trace element and other analysis will be run. Oral approval has been obtained from the U. S. Bureau of Mines for the budget for the proposed work.

Representatives of Kaiser Engineers reported that they had been directed by the U. S. Bureau of Mines to proceed with the design for the large-scale pilot plant using the clay/hydrochloric process. This is a one year design study to be completed in March 1979.

The GAO representatives are compiling information to be used for a report on the entire U. S. Bureau of Mines Alumina Program. The research team discussed with them the involvement of Georgia Tech and Georgia in the program to date. They requested copies of each of the reports that have been published under this project. These reports have been forwarded as requested. It is believed that the GAO report will assist in the continuation of the project to a final successful conclusion.

Information and suggested questions to be asked at the U. S. Bureau of Mines Appropriations Hearings were forwarded to be used when the budget is discussed by the House and Senate. It is hoped that this will help in getting on the record the need for federal funds as a follow-on to the overall alumina study of the U. S. Bureau of Mines.

A meeting was held with Pechiney in New York City to obtain their views on water consumption for an alumina from kaolin facility for Dr. Husted's project with the Office of Water Research and Technology. Pechiney has operated a 18-20 ton-per-day pilot in France for over a year, hence have good information on such items as water usage. Because a sulfuric acid process is estimated to use more water than a hydrochloric acid process, Pechiney information was useful to establish adequacy of water for various sites. Information on this will be included in later reports on this project.

Contacts have been maintained with industry and government with the research team effort being directed toward monitoring the efforts of industry and government and being of assistance where possible.

Information has been received indicating that the August 1978 issue of the National Geographic Society magazine will carry an article on aluminum. Georgia's kaolin reserves will be included in this article.

The plans and objectives of the research team in the coming quarter are to continue to monitor the U. S. Bureau of Mines alumina miniplant program and the progress of the overall program. Contacts will be maintained with the U. S. Bureau of Mines and interested aluminum companies.

Assistance to the Department of Industry and Trade will be continued as requested.

Sincerely,

William C. Ward, Jr.
Associate Director
Technology and Development Laboratory

cc: Mr. William C. Hawthorne (5)
Mr. John Overstreet
Dr. John E. Husted
OCA (2)
File A-1458

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

August 1, 1978

Georgia Department of Industry and Trade
1400 Omni International North
P. O. Box 1776
Atlanta, Georgia 30301

Attention: Mr. James O. Bohanan

Subject: Quarterly Progress Report (No. 24) on Industrial Development Research, Project No. A-1458, "Implementation of Alumina from Kaolin Potentials," Period May 1-July 31, 1978.

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following quarterly progress report is submitted.

During the quarter, Dr. John E. Husted visited Washington, D. C., Greenwich, Connecticut, and Louisville, Kentucky, concerning an alumina from Kaolin pilot plant.

In Washington, it was determined that the present estimated total cost of an alumina from kaolin pilot plant is approximately $60 million. This was a U. S. Bureau of Mines estimate.

Data are incomplete from the Bureau of Mines mini-pilot plant in Boulder City, Nevada, and it is estimated that there has been at least a year's slippage in the time for starting a full-scale pilot plant. The design for the full-scale pilot plant using the clay/hydrochloric acid process being done by Kaiser Engineers is scheduled for completion in March 1979, with the final report to be submitted in April or May 1979.

The Federal Preparedness Agency (FPA) of the General Services Administration (GSA) lists aluminum as one of the most critical materials in time of national emergency and wants to have a domestic source available. FPA is proposing a $1.8-million funding for planning and final design of a pilot plant in the 1980 Federal budget. They view a domestic alumina industry using kaolin as a high priority defense item. At FPA's request, we supplied Mr. Robert L. Brock of FPA with copies of the four publications published by Georgia Tech, under this project, on alumina from kaolin. In addition, a copy of Dr. Husted's Mining Congress Journal article was furnished Mr. Brock.

Mr. Hubert Harris of OMB emphasized that federal support for an alumina from kaolin pilot plant should be matched at least on a dollar for dollar basis by industry. He further stated that he would like to see industry repay the government with a negotiable schedule from profits, should there be a future profit to the process. Mr. Harris was emphatic that the pilot plant should be well supported both on an economic and national security basis.

Mr. Meechem of Anaconda's Washington office and Mr. Bob Maier of Kaiser's Washington office were each informed of Mr. Harris' views.

Mr. H. M. Simeon, Vice President, Corporate Commercial Development, AMAX, Greenwich, Connecticut, was presented the concept of AMAX's participation in an alumina from kaolin plant having a broader concern that might be assumed, because of their position in coal. Mr. Simeon was informed that it takes approximately one ton of coal per ton of alumina in an alumina from kaolin facility.

As a follow-up of the visit to Mr. Meechem of Anaconda, Dr. Husted was invited to visit with Anaconda Aluminum Division's administration in Louisville, Kentucky. Present at the meeting were R. P. Van Horne, President, Anaconda Company, Aluminum Division; E. W. Everett, Vice President and General Manager Primary Operations; Krest Cyr, Vice President and Chief Counsel; Fred N. Mudge, Director of Operating Services; and Robert Sullivan, Alumina Operations Manager. Anaconda stated that if money was the only consideration that they would be willing to contribute between one-fourth and one-half of industry's share of a pilot plant.

Dr. Arthur Shantz, GAO Audit Officer, is in charge of the study by the General Accounting Office on the Bureau of Mines Alumina Development Program. Dr. Shantz visited with the Research Team, a representative of the Georgia Department of Industry and Trade, and the Director, Environmental Protection Division, Georgia Department of Natural Resources, on 26 June 1978.

Dr. Shantz and his group are investigating the program nationwide and worldwide. He will pull all the information together and publish his report in February 1979, prior to the final review of the Fy 1980 budget.

Dr. Shantz was given a review of Georgia activities, strategic implications, domestic alumina sources, economic feasibility, non-Bauxitic research, pilot plan funding, and environmental considerations. Dr. Shantz requested additional information on anorthosite and Alcoa's withdrawing from the program. This information was furnished.

Mr. Walter Lippman of Toth Aluminum Corporation telephoned and stated that in the very near future they should have an announcement relative to the Toth process. He stated that a major consulting firm had reviewed their process and were ready to invest in a full-scale pilot plant.

Beginning in July, Dr. Husted started a project to characterize kaolin as an ore of aluminum for the U. S. Bureau of Mines. The study will be of 100 samples, mostly from the Wrens district, to determine trace elements, etc., that may affect alumina production. Phosphorus and fluorine will be of particular interest. The project is scheduled for completion March 31, 1979.

The water management project is essentially complete. A 14-inch well with two four-inch wells was drilled at a test site in Southeast Glascock County. Pumping data is not yet complete.

Contacts have been maintained with industry and government with the research team effort being directed toward monitoring the efforts of industry and government and being of assistance where possible.

As previously reported, information has been received indicating that the August 1978 issue of the National Geographic Society magazine will carry an article on aluminum. Georgia's kaolin reserves will be included in this article.

The plans and objectives of the research team in the coming quarter are to continue to monitor the U. S. Bureau of Mines alumina mini-plant program and the progress of the overall program. Contacts will be maintained with the U. S. Bureau of Mines and interested aluminum companies.

Assistance to the Department of Industry and Trade will be continued as requested.

Sincerely,

William C. Ward, Jr.
Associate Director
Technology and Development Laboratory

cc: Mr. William C. Hawthorne (5)
Mr. John Overstreet
Dr. John E. Husted
OCA (2)
File A-1458

October 31, 1978

Georgia Department of Industry and Trade
1400 Omni International North
P. O. Box 1776
Atlanta, Georgia 30301

Attention: Mr. James O. Bohanan

Subject: Final Quarterly Report (No. 25) on Industrial Development Research, Project No. A-1458, "Implementation of Alumina from Kaolin Potentials," Period August 1--October 31, 1978

Gentlemen:

In accordance with Paragraph 7 of Project A-1458 Agreement, the following final quarterly report is submitted.

During the quarter, Dr. John E. Husted visited Washington, D.C. and Boulder City, Nevada, concerning an alumina from kaolin pilot plant.

In Washington in conjunction with attendance as an observer at a meeting of the advisory committee to the Secretary of the Interior for Title III of the Surface Mining and Reclamation Act of 1977, visits were made to the U.S. Bureau of Mines, the Office of Federal Preparedness of the General Services Administration, and to the General Accounting Office.

Ralph Kirby, Assistant for Metallurgy, was visited at the U.S. Bureau of Mines. In addition to discussing the alumina program in general, a report was made concerning our progress on the characterization of kaolin as an ore of aluminum project. Mr. Kirby reported that sparging was moving satisfactorily at the Boulder City, Nevada Metallurgical Research Laboratory, however physical changes in the system need to be made. Completion times, for this research may have to be extended.

Robert L. Brock of the Federal Preparedness Agency stated that the request for funds to be budgeted for an alumina from kaolin pilot plant was in the hands of their director and was ready to be recommended to the Office of Management and Budget.

Dr. Arthur Shantz, GAO Audit Officer, who is in charge of the study, by the General Accounting Office, on the Bureau of Mines Alumina Development Program stated that a request for his report through Senator Talmadge's office would get us an advance copy of his draft report. It is our understanding that the Georgia Department of Industry and Trade will request a copy of the report. Dr. Shantz is touting dawsonite from oil shale despite many negative reports from various sources. He did state, however, that his report on Georgia kaolin and the HCl process would contain no reference to dawsonite.

A visit was made to the Boulder City, Nevada, Metallurgical Research Laboratory of the U.S. Bureau of Mines. The pilot plant was not in operation at the time because they were making physical-mechanical changes in the sparging-centrifuge system to get better flow of material. No changes in the chemical flow sheet or types of equipment are currently contemplated. There is still some concern with phosphorus in the kaolin.

Contacts have been maintained with industry and government with the research team effort being directed toward monitoring the efforts of industry and government and being of assistance where possible.

Since this is the final quarterly report we have prepared a brief summary, which is attached, of Georgia Tech's Alumina from Kaolin Efforts. It is believed this summary will be useful in the Department's discussions with interested parties in the future.

Sincerely,

William C. Ward, Jr.
Associate Director
Technology and Development
Laboratory

Attachment

cc: Mr. William C. Hawthorne (5)
Mr. John Overstreet
Dr. John E. Husted
OCA (2)
File A-1458

SUMMARY:

Georgia Tech's Alumina from Kaolin Efforts

The thrust of the research conducted by the Georgia Institute of Technology under contract to the Georgia Department of Industry and Trade has been toward the realization of the potential of an alumina industry in Georgia. The contract has been funded since its initiation by the Coastal Plains Regional Commission.

A pilot plant in Georgia for the production of alumina from kaolin is essential to full alumina production facilities. The production of alumina from this very important domestic source will be of large economic and strategic benefit to the nation. This will be true in off-setting balance-of-payments, an improved national defense posture, an improved tax base, improved southeast employment, improved negotiating base with bauxite countries, and improved strategic logistics. Because of the above mentioned items and because approximately 90 percent of our aluminum raw materials are imported, in part from potentially unreliable sources, because of the importance of aluminum in lowering energy requirements in transportation, because of the importance of aluminum to our total industrial economy, because of the lead time required for Georgia's domestic source of aluminum to be realized, we therefore urge the Office of Management and Budget to implement an adequate budget to support a pilot program of making alumina from kaolin in Georgia.

The work contract for this program with Georgia Tech has produced the following publications.

1. "Alumina from Kaolin Potentials" - 1972.
   This report established the technical and economic feasibility of producing alumina from kaolin and brought Georgia's extensive (over 3.5 billion short tons) kaolin reserves to the attention of the aluminum industry. It also pointed to problems of nationalism in producing countries and to problems of strategic logistics. It recommended a pilot by the U.S. Bureau of Mines.

2. "Alumina from Kaolin" - 1974.
   This report called attention to the 180 degree change in attitude of the aluminum industry since 1972 and the U.S. Bureau of Mines-Industry mini-pilot plant program started in 1973. In addition, it summarized available kaolin reserves in Georgia as well as state-of-the-art technology and economics.
3. "Alumina from Kaolin Environmental Considerations" - 1976.
   This publication abstracted the environmental laws and regulations of the State of Georgia and related them to a potential alumina from kaolin facility.
4. "Alumina from Kaolin--II" - 1977.
   This report updated information on the advancing technology and economics of obtaining alumina from kaolin and gave a timetable of an alumina from kaolin facility in Georgia. In addition it identified several potential sites for such an industry.

In order to enhance the program and call attention to the potential of Georgia's aluminum ores, Dr. John E. Husted of Georgia Tech and a Co-Principal Investigator of the Project has published or presented papers as follows:

1. "Potential Reserves of Domestic Non-Bauxite Sources of Aluminum," presented at The Metal Society, AIME, annual meeting, 1974. Information was based on a study made for the U.S. Bureau of Mines' MAS program.
2. "An Integrated Aluminum Industry for Georgia--Concerns and Outlook," presented to The Metal Society of AIME, Annual Meeting (Atlanta), March, 1977. Costs and a potential timetable were given.
3. "An Integrated Aluminum Industry for the Southeast--Concerns and Outlook," Mining Congress Journal, September 1977, pp. 28-33.

This article was a publication of the paper in item 2 above and puts in perspective the expected realization of an integrated aluminum industry in Georgia based on Georgia's reserves of kaolin.

4. "Kaolin--A Potential Ore of Aluminum," presented at Fall Meeting of The Society of mining Engineers, AIME, October 20, 1977.

Dr. Husted also has an ongoing project with the Office of Water Resources and Technology, U.S. Department of the Interior, entitled, "Optimum Water Management for an Alumina from Kaolin Facility." This project is nearing completion and will provide water management guidance when an alumina facility is built in Georgia.

A project with the U.S. Bureau of Mines entitled, "Research Proposal for a Study of Characterization of Kaolins as Ores of Aluminum" was begun in July, 1978, and is expected to be completed by the end of March 1979. The contract calls for 100 samples to be analyzed. Work under this project is on schedule, with a total of 135 samples collected with the majority being from the Wrens area.

Continuous and up-to-date liaison has been maintained by Georgia Tech with the U.S. Bureau of Mines' mini-pilot facility, the aluminum industry, and the Georgia Department of Industry and Trade. The program's priority was the establishment of an alumina-aluminum industry in Georgia based on Georgia's kaolin reserves. An alumina from kaolin pilot in Georgia is the ongoing priority. It is toward this end that the above mentioned project to characterize kaolin as an ore of alumina is being directed. Results from this study will be particularly important in the design criteria for a large pilot plant. Work with Georgia kaolins at the U.S. Bureau of Mines' pilot plant in Boulder City, Nevada, has indicated that phosphorous in particular, and possibly some other elements, could be a problem in the final crystallization stage of the hydrochloric acid process. Additional studies need to be made in this and other areas.

Because of the need for more definitive technical work and a refining of process technology, other work such as final design and other aspects of a large pilot plant must be delayed until these problems have solutions. At least a year is foreseen of an ongoing technical program before a pilot will be funded and started.

In the interim, to the extent possible without funding, Georgia Tech will attempt to keep abreast of work in progress and other matters pertaining to this important potential for Georgia industry.

Project A-1343

ALUMINA FROM KAOLIN POTENTIALS

Prepared for
Georgia Department of Industry and Trade

by

William C. Ward, Jr.

Dr. John E. Husted

William C. Howard

Amy Collins

Industrial Development Division
Engineering Experiment Station
GEORGIA INSTITUTE OF TECHNOLOGY

April 1972

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<u>Tables</u>

<u>Appendix Table</u>

Acknowledgments

Many people and organizations have been consulted during the course of this investigation and each has assisted with very helpful input of information and critical reviews and discussions. We gratefully acknowledge each of them as follows:

Aluminum Companies

Aluminum Company of America
Amax Aluminum Company
Anaconda Aluminum Company
Kaiser Aluminum and Chemical Corporation
Reynolds Metals Company
National-Southwire Company
The Aluminum Association

Kaolin Companies

Engelhard Minerals and Chemicals Corporation
Freeport Minerals Company
Georgia Kaolin Company
J. M. Huber Corporation
Thiele Kaolin Company

Other Non-Government

R. W. Hyde of Arthur D. Little, Inc.
Sandersville Railroad Company

Federal Government

The Interior Department
U. S. Bureau of Mines
The Georgia Delegation to the United States Congress

State Government

Various State of Georgia Agencies

This report has been the responsibility of the Industrial Development Division of the Engineering Experiment Station at the Georgia Institute of Technology (Georgia Tech).

The need for this study was mutually recognized and discussed by Col. Harold Dye of the Georgia Department of Industry and Trade, the late Dr. George I. Whitlatch of the Industrial Development Division, and Dr. John E. Husted of the Engineering Experiment Station's Technology Applications Group. As a result of these discussions, an alumina-from-kaolin seminar, co-sponsored by the Georgia Department of Industry and Trade and the Georgia Institute of Technology, was held in Atlanta in September 1970. The National-Southwire Company was the host for the seminar. Attendance was by invitation only, and attendees were key representatives of the aluminum and kaolin industries and government agencies. The issuance of the NMAB Report 278, "Processes for Extracting Alumina from Nonbauxite Ores," in December 1970 is regarded as having been at least partially spurred by this meeting. Subsequently, the Georgia Department of Industry and Trade secured funding from the Coastal Plains Regional Commission which it in turn subcontracted with Georgia Tech for the study reported herein.

The principal author of this report is Dr. John E. Husted. William C. Howard is mainly responsible for Chapter 6. Mrs. Amy Collins was most helpful in the analysis of statistical data in Chapter 3. William C. Ward, Jr., the Project Director, was responsible for the overall project and coordinated the efforts of the project team.

Summary

The following summary is to show pertinent information or objectives by chapters. Detail for numbered statements may be found in the chapters of the same number.

1. The United States aluminum industry has grown from less than 500 pounds of primary aluminum supply in 1885 to approximately 3.9 million short tons of capacity of primary aluminum and an estimated total consumption of aluminum of 5.38 million tons in 1969. Domestic scrap recovery in 1969 raised total United States aluminum supply to 4.82 million tons, which was still less than consumption. Average growth rate projections are between 5.1% to 7.4% per year or between 21.2 and 42.0 million short tons of consumption by the year 2000 for the United States. The free-world growth has been projected at an annual rate of 5%.

2. If bauxite should continue to be the sole source of aluminum, the United States by 1980 will need to import 95% of its primary aluminum needs and even more in succeeding years. Aluminum producers in the free world still use (with modifications and improvements) the Hall-Heroult aluminum reduction process of 1886 and the Bayer-bauxite process of 1888 for making alumina because they are still the most economic means to meet aluminum demand.

Raw materials that have been investigated in the United States are summarized in the National Materials Advisory Board Report 278. Favored, and recommended for an integrated pilot plant operation, is a nitric acid leaching of kaolin to produce alumina. Present information indicates this to be within competitive range of the Bayer-bauxite process. Reserves of kaolin are more than adequate.

3. Balances of trade minimum projections, based on importation of bauxite and alumina, indicate outflow of United States dollars will be in the amount of $294 million for 1972 and rising annually to $835 million for 1985. This is a minimum dollar estimate that does not allow for increased nationalization by source countries, which could increase this by perhaps 10 to 40 fold.

4. Research is needed in the form of integrated pilot plants to give a substantial technical and economic base for scaling up to commercial plants. Lowest cost per ton of alumina from kaolin as now projected, based on 1972 costs, is approximately $62, without the recommended depletion, as compared

with a reported $48 for current Bayer-bauxite processing. With the recommended depletion, cost per ton of alumina from kaolin would be approximately $48. This needs confirmation by integrated pilot plants. In addition, the pilot plants are needed to find working solutions to environmental problems.

Projected is a first 5-ton-per-day nitric acid process kaolin-to-alumina pilot plant. Based on data from this plant a 50-ton-per-day pilot is projected, to be followed probably with 1,000-ton-per-day first generation commercial plant(s). The 1,000-ton-per-day commercial plants are expected to be experimental plants.

The 5-ton-per-day pilot plant is projected to take from three to four years, with a total cost not to exceed $20 million or no more than $8 million in any one year for both operating and capital costs. Cost of a 50-ton-per-day pilot plant will need to be determined from operating data derived from the 5-ton-per-day plant.

5. An alumina-from-kaolin industry would take six to eight years, under normal procedures, to advance from a 5-ton-per-day pilot plant to a 50-ton-per-day pilot plant to a 1,000-ton-per-day first generation commercial plant. Hence, under normal procedures, tonnage and dollar impact would not be expected until after 1980 if pilot plants begin in 1973. The extent to which this can be accelerated is not known, since neither a starting date for a pilot plant nor the number of first generation commercial plants and their timing can be predicted at this point. Presidential executive action could probably move the starting time up to sometime this calendar year (1972).

An immediate and continuing favorable impact on trade negotiations is expected from a first pilot plant effort.

6. A nitric acid commercial kaolin-to-alumina plant of 1,000 tons of alumina per day is expected to employ in excess of 250 skilled or semiskilled persons directly, with an indirect employment increase of 1,000 persons for services, trade, education, etc.

Revenue impact in taxes is expected to be on the order of $650 thousand as based on a $50 million plus investment and the number of new jobs for each first commercial plant of 1,000 tons per day.

7. The initial impact on the kaolin industry is expected to be the move to secure kaolin reserves by the aluminum industry. A serious production impact is not anticipated until second generation commercial plants come on stream. In general, excepting possible by-product silica competition in the filler and pigment markets, the impact should be favorable since much clay not currently usable will be acceptable to the aluminum industry.

8. Satellite industries using alumina could add to the industrial growth of the area. Supply industries and transportation are not expected to be greatly affected until second generation plants are in operation.

9. Some of the environmental considerations to be investigated are hydrological impact, control of fumes, and control of effluent materials. These determinations are also objectives of the pilot plant operation.

CONCLUSIONS AND RECOMMENDATIONS

A review of the use of bauxite as the only primary source of alumina and aluminum has revealed that the United States is in a vulnerable, if not dangerous, position concerning supplies of this important metal. Current domestic supplies are on an order of 11% of annual need and are projected to be 5% by 1980 and less by 1985. The nation's vulnerability is in at least three areas:

1. Supplies for the domestic aluminum industry constitute a dollar outflow of approximately $294 million currently, with a projected annual outflow of approximately $835 million by 1985 if bauxite is continued as the only source of alumina and aluminum. This could be increased approximately fourfold if nationalization of present sources requires all bauxite to be converted to alumina before shipment and possibly forty-fold if it must be converted to aluminum.

2. The current and projected dependence of the United States on foreign bauxite for alumina and aluminum has deteriorated the nation's negotiating position on the international market. Further, it has and will subject the U. S. to increasing economic pressures. This could take the form of full expropriations, as was the case of copper in Chile, or encroachment of management and profits. Pressures probably will mount to produce more alumina, aluminum, and aluminum products in foreign countries, which would further erode the United States' trade deficit position as noted in paragraph 1 above.

3. In addition to the above economic and political vulnerabilities, the United States is and will continue to be in the dangerous position of strategic logistical exposure as foreign bauxite and alumina move to this country by water. Despite national stockpiles, this is still true as has been developed in Chapter 5 of this report.

The present problem, however, is not that the United States actually lacks adequate sources of aluminum-bearing minerals. The problem has been the economic advantage of the technology of using bauxite versus the economics of technologies of other aluminum-bearing minerals. Until about 10 years ago there also may have been some questions of domestic reserves. During the immediate past decade, however, enormous domestic reserves of kaolin have been discovered, and research by the U. S. Bureau of Mines and by industry has brought kaolin to what appears to be a competitive position with bauxite.

The question is what is to be done and how to proceed in implementing an economically competitive, self-sufficient domestic alumina-aluminum supply. The action recommended in this report is directed toward giving answers to this question.

Federal Government

Direct Financial Action

1. It is recommended that direct full funding be allocated to be used or administered by the Bureau of Mines, United States Department of the Interior, in cooperation with industry, for the purpose of definitive research directed toward obtaining the best economic and technical method(s) for obtaining alumina from domestic sources in large supply. On the basis of present information, it is recommended that a nitric acid process for clay, using the best available knowledge, be tested in a 5-ton-per-day integrated pilot plant to determine if operational technology and estimated cost of operation are correct and may be scaled to a larger plant. Recommended is an allocation total of $20 million for four years, not to exceed $8 million in any one year for a 5-ton-per-day pilot plant.

If the 5-ton-per-day pilot plant proves technical feasibility and economic justification, it is recommended that direct full funding be allocated for a 50-ton-per-day pilot plant, with administration through the U. S. Bureau of Mines continued. Cost of this funding will have to be determined after data are available from the 5-ton-per-day pilot plant. Unit costs are expected to be much lower.

In addition, such a pilot operation should provide methods of solving legal and technical problems that could arise concerning the environmental impact of mining and processing.

2. It is recommended that low-cost loans, appropriately funded, be made available or guaranteed by the federal government for construction of at least the first commercial plants operated by private industry for the production of alumina from domestic kaolin.

Rationale of Direct Financial Action

Consensus of aluminum industry representatives interviewed during the course of this study is that later generations of plants using kaolin as a source of alumina would have a decided economic competitive advantage over earlier experimental plants. This is expected to be true both because of technological improvements that could be used in the new plants and because of economies that could be effected by larger scale plants.

Such advantages would place an unfair economic burden on those companies whose risk capital was tied up in experimental models, whereas companies not so burdened could proceed with investments based on better technology. It is concluded, therefore, that the federal government, to protect its own interest, would be justified in supplying the risk capital to effect technological improvements projected as results from experimental or pilot plants and needed for the competitive production of alumina from domestic kaolin. On the other hand, no company can justify use of its risk capital for the benefit of its competitors.

Tax Relief Action

1. It is recommended that legislative action be taken that will permit depletion allowances for clay (kaolin) and other domestic minerals to include as mining costs all processing steps through the production of alumina, when used as a primary ore of aluminum. This should be an amendment to Title 26, Section 613, c, 4, of the Internal Revenue Code.

Under 613 (c) Definition of Gross Income from Property, (4) of the Internal Revenue Code, the following should be added:

> In the case of clay (kaolin), laterite (including bauxite), anorthosite, alunite, and nephelite syenite extracted from deposits in the United States, all processes applied to derive an aluminum compound, such as alumina, as the process steps immediately preceding production of aluminum, shall be considered as mining.

2. It is recommended that investment credit be given against taxes, consistent with federal investment credit practice, for capital investments in pilot or regular plant construction of a facility to produce alumina from kaolin.

Rationale for Tax Relief Action

1. Ores of metals customarily have the percentage allowance for depletion applied against process costs in bringing ore to a step that is usually immediately prior to the production of usable metal. As examples, blister copper is used for copper, cyanidation for gold, etc.: Internal Revenue Code (613) (c) (4) (D). It seems illogical to permit other metals to reach a process stage, such as with one-half of one percent copper ore to blister copper, and not allow the same for kaolin to alumina.

2. Investment credit seems to be a useful means of lowering some of the financial risk through tax relief in order to start a new domestic industry which promises so much strategic and financial relief to the nation. It is important in the initial stages of development to offset present operating economies accruing to the use of foreign bauxite and to accelerate plant construction.

Other Federal Action

1. It is recommended that, to the extent feasible, rail rates for the transportation of domestic alumina from kaolin to reducing plants be made competitive with water rates for alumina derived from foreign sources to the same plants.

2. It is recommended that legislative action be taken to assist secondary or spin-off industries of alumina production in rural areas. Such legislative action would be in line with reversing the trend of migration from rural to urban areas.

State and Local Government

Tax Relief

1. It is recommended that sales tax on utilities be exempted, since it is anticipated that commercial alumina plants will be large consumers of fuel, electricity, and other utilities. This would assist in making utilities more competitive with other regions of the nation who have very low utility rates.

2. It is recommended that a thorough study be made by appropriate taxing bodies of other possible tax relief. The advantages of encouraging a new

industry should be carefully weighed against the costs of services that state or local governments would need to furnish and pay for.

3. Assessments for taxes of the new industry should be as equitable as possible.

Other Action

1. The General Assembly of Georgia should pass resolutions requesting the Georgia delegation to the Federal Congress to support the foregoing recommendations.

2. The Governor of Georgia and other high officials should make known publicly their encouragement to establish this new industry and the recommended action to implement it.

3. The General Assembly of Georgia should work with industry to secure equitable and workable regulations concerning environmental/ecological controls. A balance must be achieved that protects the public without eliminating industry.

Chapter 1

BACKGROUND OF THE ALUMINUM INDUSTRY

Historical Development

Sir Humphry Davy designated the metal of the oxide alumina as "alumium" in 1808 and later changed it to "aluminum." In many countries the spelling was later changed to "aluminium." Bauxite was discovered in France in 1821. Hans Christian Oersted produced the first elemental aluminum in 1825. Henri St. Claire Deville, using chemical reduction in batch procedures, produced the first commercial aluminum in 1854 in France. Prices in 1857 and 1859 were $27 and $17 per pound, respectively.

In 1884 the first American bauxite was discovered near Rome, Georgia. In 1885 less than 500 pounds of aluminum were produced in the United States from foreign ore. In 1886 Charles Martin Hall in the United States and Paul Heroult in France independently discovered the continuous electrolytic process, which basically is the process still used for producing the metal aluminum from alumina. In 1888 Karl Bayer invented the current commercial process for producing alumina from bauxite. In 1889, 728 tons of bauxite were mined near Rome, Georgia, being the first United States production. In 1899 the first Arkansas bauxite was mined in the amount of 5,045 tons. Until World War I more than 95% of the bauxite produced came from mines in the United States and France. Mines in British Guiana started shipment in 1917 and Surinam in 1922. Bauxite production began in Russia in the late 1920's.

The Aluminum Industry in the United States

The Aluminum Company of America (Alcoa) was the only United States producer of primary aluminum from 1886 until 1940. World War II needs required much larger amounts of aluminum and gave impetus to new production facilities. Reynolds Metals Company began production in 1941. Kaiser Aluminum and Chemical Corporation purchased surplus World War II plants and entered production in 1946. Anaconda Aluminum Corporation's first production was in 1954 and that of Ormet Corporation and Harvey Aluminum, Incorporated, each in 1958. A Swiss-owned company, Consolidated Aluminum Corporation (Conalco), began United States production in 1963; Intalco Aluminum Corporation, in 1966; National-Southwire Aluminum Company, in 1969; and Eastalco, a Howmet-Pechiney subsidiary, in 1970. Although refinements and improvements have taken place, 1972 aluminum production still results from the Hall-Heroult reduction process of 1886 and the Bayer bauxite-to-alumina process of 1888.

Aluminum Consumption and Capacity

Beginning in 1954, primary aluminum became first in nonferrous metal production and second to ferrous metal in the metal production of the United States. Estimated growth rate, with obviously some fluctuations, is pegged to population increases and resulting increases in construction and consumer products. N. V. Davis, President of Alcan Aluminum, Ltd., projects free-world consumption to grow at an annual rate of 5% instead of the 8% of the past decade and as compared with the U. S. Bureau of Mines projection of 5.1% to 7.4% for the United States. (Ref. 1.)

Excluding national defense stockpiles, supplies of aluminum to the United States from all sources, including scrap, rose from 0.9 million tons in 1949 to 5.38 million tons in 1969. (Ref. 2.) This supply included 3.79 million tons of domestic primary production and recovery of 1.03 million tons of domestic scrap, or 4.82 million tons of domestic aluminum supply in 1969. In the more recent past, the upward movement of consumption of aluminum with corresponding supply has continued.

The U. S. Bureau of Mines showed 1968 demand at 4.31 million tons, with projected demand between 21.2 and 42.0 million tons in the year 2000. (Ref. 3.) I. Lipkowitz estimated United States consumption of aluminum to have been 4.56 million tons in 1968, 4.906 million tons in 1969, 4.475 million tons in 1970, and 4.866 million tons in 1971. (Ref. 4.) This reflects the 1970 economic decline but shows an up-turn in 1971. Obviously there will be annual fluctuations, up and down, from average projections, but the trend is up.

United States primary aluminum capacity in 1969, as shown in the Aluminum Association's annual statistical review for that year, was 3.9 million short tons. (Ref. 2.)

With capacity of primary aluminum at 3.9 million short tons, current consumption at 4.5 to 4.9 million short tons, and projected consumption or demand between 21.2 and 42.0 million short tons by the year 2000, the need for new capacity in the United States is obvious.

Aluminum consumption and capacity has been growing in the rest of the world also. Countries in the European Common Market with mature economies probably will be a strong source of competition both for sales and supplies. Many less developed countries with raw material sources of alumina likely will continue to insist on integrating aluminum production at least to the metal and possibly to products as part of nationalization.

Chapter 2

ALUMINUM SUPPLIES AND TECHNOLOGIES

Present Bauxite Ore Sources

Bauxite is the only ore of aluminum used at present for commercial production of aluminum in the free world. Bauxite is a heterogenous mixture of impure hydrous aluminum oxide minerals. The principal minerals are gibbsite, $Al(OH)_3$; boehmite, $AlO(OH)$; and diaspore, $AlO(OH)$. Major impurities are iron and titanium oxides and aluminum silicates. The relative amounts of these minerals and impurities vary from deposit to deposit.

Bauxite was formed by a lateritic weathering process in which iron and aluminum silicates were decomposed, and silica (along with many other elements) were removed by natural leaching. This resulted in a concentration of iron, aluminum, and other remaining hydrous oxides (usually surface or near surface). In general, laterization is favored by humid tropical climates and relatively flat-lying material.

Because bauxite deposits are found frequently at the surface or near surface, open-pit mining methods and large equipment are usually used, which in turn makes for lower unit costs for the mined material.

The latest available production and import figures from the U. S. Bureau of Mines' Minerals Yearbook for bauxite and alumina were for 1969. (Ref. 5.) In that year the United States produced 1,843,000 long tons of bauxite, as compared with 12,180,000 long tons of imported bauxite. Of domestic bauxite, 95% came from Arkansas. The imported bauxite was approximately 87% of total imported and domestically produced bauxite. The domestic bauxite was valued at $25,725,000 and the imported bauxite at $165,802,000.

In 1969 the United States also imported 1,912,000 short tons of alumina valued at $106,333,000. This, with bauxite imports, constituted $272,135,000 for imported raw materials for aluminum for 1969.

The 1969 imported bauxite was derived as follows: 59% from Jamaica, 23% from Surinam, 8% from the Dominican Republic, and the remaining 10% from Haiti, Venezuela, and Guyana.

Australia furnished 69% of the imported alumina, with Surinam and Jamaica supplying most of the remainder.

Future Sources Based on Present Production Technology

The U. S. Bureau of Mines indicated in 1970 that annual production of domestic bauxite would continue at about 400,000 tons (aluminum content) per year until the year 2000. (Ref. 3.) There was estimated to be an aluminum content reserve of 12,800,000 tons. Approximately 55 million tons of aluminum content were believed to be recoverable from domestic low-grade bauxite ores that are not economically feasible at present. The world reserve of bauxite on an aluminum content basis was set at 1.2 billion tons in 1969, but it is probably at least 2 billion by now (1972) because of new discoveries.

The aluminum content of domestic bauxite met only 11% of the demand in 1968, with an average of 13% for the period 1965-1969, a projection of 8% for 1970-1975, and only 5% in 1980. (Ref. 6, p. 12.) Within eight years it is projected that 95% of the United States' requirements for primary aluminum will be imported, if present trends continue.

All of this will move by water transportation from foreign sources. With the growing trend of many nations toward nationalization, the probability is that much of this country's aluminum requirement of the future will be shipped as alumina or aluminum ingots or products. Economics of transport and technology favor alumina since shipping costs are about the same as for bauxite and the production facilities are less demanding than those required in producing the metal.

Technology of Production of Aluminum from Bauxite

As stated previously, most bauxite deposits lend themselves to low-unit-cost mining by open-pit methods.

The current processing of bauxite to produce alumina is by the Bayer method or some variation of it. The Bayer process was patented in 1888 in Germany. The Bayer process consists essentially of a caustic leach of bauxite at high temperatures and pressures. Differences between the American and European Bayer processes are that the American process uses less caustic, lower temperatures, and lower pressures. (Ref. 7.) The resulting sodium aluminate solution is separated, followed by selective precipitation of a relatively pure hydrated aluminum oxide ($Al_2O_3 \cdot 3H_2O$). This material is filtered, washed, and then calcined. The calcined product is the furnace feed in making aluminum.

Primary aluminum is produced by the electrolysis of alumina in a molten bath of cryolite. Purity of the alumina must be greater than 99.5% Al_2O_3 on a dry basis.

In general, 4.5 short tons (4 long tons) of bauxite yields 2 short tons of alumina and 1 short ton of aluminum. Through improved technology, there has been some small increase in yield over the years.

Currently there is no competitive free world process or source of aluminum.

Other Possible Future Sources and Technologies of Production

The primary concern of this report is the consideration of the use of domestic sources of aluminum raw materials. Because of the scarcity of domestic bauxite, other domestic materials and processes must be considered. In all cases, reserves of ore and competitive economics are the key factors to utilization of a domestic source of aluminum. Foreign raw materials, other than the previously discussed bauxite and alumina, will not be discussed.

In December 1970, the National Materials Advisory Board (NMAB) issued a report entitled Processes for Extracting Alumina from Nonbauxite Ores. (Ref. 6.) The summary of conclusions and recommendations from this report is quoted in its entirety in Appendix 1.

The study covered by the NMAB report considered the following raw materials: clay, dawsonite, aluminum phosphate rock, anorthosite, copper leach solutions, saprolite, aluminous shales, alunite, and coal ash. On the basis of the domestic quantity available or the economics of processing, the NMAB report eliminated all of the above materials except clay and dawsonite. Anorthosite has been reported to be under reconsideration and will be discussed briefly. A current evaluation of an alunite deposit has been announced as under study in Utah.

Kaolin. Of the above materials, clay (kaolin) appeared in the NMAB report to have the best potential, with a nitric acid (Nuvalon) process for obtaining alumina from clay having the lowest projected cost per ton of alumina.

The reserves of kaolin in Georgia alone appear more than adequate for years to come. Many of these deposits meet large usage mining requirements in terms of size and location. Information from proprietary sources in the kaolin industry has indicated approximately 3 billion tons of kaolin reserve south of the Fall Line between Augusta and slightly west of Macon. The Georgia Department of Mines, Mining, and Geology has stated that there is at least an additional 2 billion tons south of the Fall Line between Macon and the Chattahoochee River. Most, if not all, of the Augusta-Macon reserve estimates are reported to be based on company drilling. An undetermined number of properties are leased under 50 year or longer agreements or are owned in fee simple by kaolin companies. The same is reported true southwest of Macon for the remaining 2 billion or more tons. At a meeting held at Georgia Tech in September 1970, at which key representatives of both the aluminum and kaolin industries were present, the above reserve tonnages were brought out on the open floor. They were confirmed verbally by representatives of the kaolin industry.

Most of the above reserves have been discovered since about 1961. The extreme proprietary nature of the kaolin industry as it has and does exist has precluded more detailed reserve information for public dissemination. This, however, does not invalidate its accuracy.

As noted above, the requirement of reserve tonnage of alumina in clays appears to be exceeded in Georgia alone. The Georgia kaolins contain about 35% alumina, with some having as much as 39% alumina. A conservative estimate has been used of 30% of the kaolin being recovered as alumina. Allowing a 2:1 ratio of alumina to aluminum, 15% of the kaolin can be recovered as aluminum, which means that roughly 1.5 billion tons of alumina or 750 million tons of aluminum can be recovered from reported reserves of kaolin in the state of Georgia.

The most promising process available for this study for recovering alumina from kaolin, on the basis of process costs per ton of alumina, is a new nitric acid method on which the patent was granted on July 22, 1971, to R. W. Hyde and S. V. Margolin and assigned to Arthur D. Little, Inc.

The nitric acid process evaluated by the U. S. Bureau of Mines and used for costs in the NMAB report was a modified Nuvalon (German) process.

As shown later in this report, when current (March 1972) utility costs for an Augusta-Macon site are substituted for the older costs used in the NMAB report, the estimated costs per ton of alumina rises from the $58 used in the report for the nitric acid (Nuvalon) process to in excess of $71 per ton. On the other hand, when current utility costs as well as 1972 construction, labor, and mining costs are used for estimating in the Hyde-Margolin process, Hyde (personal communication) estimates a cost of less than \$62 per ton of alumina or approximately \$48 per ton with the recommended depletion. This may be compared with costs reported in the NMAB study of \$47 per ton of alumina by the Bayer-bauxite process which is reported to have risen to \$48 per ton in 1972.

The reduction of costs by the Hyde-Margolin process over the Nuvalon process appears to be effected by use of less energy and time. A step-by-step comparison of temperature requirements shows that in each instance, excepting calcining, the Hyde-Margolin process operates at lower temperatures. In addition, heat is systematically carried forward from step-to-step in continuous flow. Time for digestion is reduced from six to three hours. Time for settling out waste silica was 14 hours in the Nuvalon process as compared to continuous flow and flocculation in the Hyde-Margolin process. Other economies are found throughout.

Dawsonite. The consideration of dawsonite [$NaAl(OH)_2CO_3$] involves mining and processing of oil shales in which dawsonite would be a by-product. Under optimum conditions the alumina content of the shale is approximately 4%. It has been considered by industry and federal agencies because of expected large quantities of calcined shale waste if oil shale is mined for the production of oil. In addition to mining costs, consideration must be given to the costs of recovering the 4% alumina content while handling, processing, and disposing of as waste the other 96% of the shale. Further, it is reported that the best sources of dawsonite are deeply buried and would be available only after a large amount of mining has taken place.

Another consideration is that in situ recovery of the oil may be attempted through nuclear processing. If nuclear in situ processing of the shales for oil is used, it would obviously eliminate their use for aluminum. If mining is used, the future is still somewhat unsettled, with a large number of undetermined variables, among which are timing, amounts to be recovered for oil, and costs per ton of alumina. The recovery of alumina is dependent on the mining of the shale for oil.

Dawsonite reserves of aluminum are immense, however, being projected as over 4 billion tons of recoverable aluminum. Because of the enormous reserves, it may well be the reserve of the future, but not the relatively near future material needed now.

Anorthosite. Also reported to be under consideration by industry as a source of alumina is anorthosite. In its favor are the large deposits of anorthosite within the United States. Most of the deposits, however, are not in easily accessible locations. Further, process costs estimated in the NMAB report, even though based on outdated equipment costs (1960) and fuel costs, came to $74.36 as the lowest projected cost per ton of alumina. Electric costs could be in line if production has access to the large hydroelectric sources of the western United States, but the estimated 2.5 cents per therm of natural gas probably should be doubled. This doubling, when applied to the steam and natural gas costs alone, would change the estimated per ton costs of alumina to approximately $88 per ton.

If the estimated costs per ton of alumina for the Hyde-Margolin, Arthur D. Little process for clay is $62 per ton of alumina, the economics of producing alumina from anorthosite in excess of $88 are obviously prohibitive.

Alunite. Alunite /$KAl_3(OH)_6(SO4)_2$/, which contains approximately 37% Al_2O_3, was rejected in the NMAB report as not being in sizable quantity in the United States. Discovery of a large deposit in Utah was announced recently. (Ref. 8.) Jointly held by National Southwire Aluminum Co. and Colorado Central Mines, Inc., the deposit is currently under investigation. Size of deposit and projected cost per ton of aluminum are still in the investigative stages. By-products from an Al_2O_3 from alunite process could be a potassium sulfate fertilizer and alum. Delivered costs of alumina to eastern reduction plants may reduce or eliminate its competition with kaolin in this area but favor it for western plants.

Direct Reduction Methods. Studies are currently being made of direct reduction methods for producing aluminum from an ore without going through present steps. A favored means has been production of $AlCl_3$ by chlorination and subsequent chemical reductions. Work reported to date has not proved feasibility according to the U. S. Bureau of Mines. (Ref. 3.)

Chapter 3

BALANCE OF TRADE CONSIDERATIONS ATTRIBUTABLE TO ALUMINA AND BAUXITE

It is estimated that imported bauxite and alumina for use by the domestic aluminum industry will contribute approximately $294 million to the dollar outflow from the United States in 1972, increasing to a projected annual outflow of approximately $835 million by 1985, if based on conservative estimates and present nationalizations.

This chapter delineates the background and methodology of determining the United States dollar outflow attributable to imported bauxite and alumina. Projected requirements for raw materials are discussed, and their probable effects on the U. S. economy in terms of imports and dollar outflow are considered.

Demand for Aluminum

Identification and the subsequent quantification of the demand for aluminum were the first steps in estimating the related dollar flows due to imported raw materials.

Table 1 lists the consumption of aluminum by U. S. industry.

Table 1

RELATIVE CONSUMPTION OF ALUMINUM BY INDUSTRY GROUP

Industry	Percent of Total
Construction	23
Transportation	20
Electrical and Communications	14
Special Machinery*	14
Consumer Durables	11
Packaging	11
Other	7
	100

* Industrial, agricultural, material handling, irrigation, chemical, metallurgical and dissipative uses.

Source: U. S. Bureau of Mines, Mineral Facts and Problems, 1970.

The U. S. Bureau of Mines has estimated that in the year 2000 domestic demand for aluminum will range between 21.2 and 42.0 million tons. (Ref. 9.) This represents an average growth rate of 5.1% to 7.4% annually.

Projections over a shorter time period are generally more reliable because technological changes which take considerable time to implement can affect performance at a later date. To reduce the probability of error, therefore, the shorter period of 1972-1985 was used in the following analysis.

The National Materials Advisory Board has calculated from the Bureau of Mines data that by 1985 the demand for aluminum in the U. S. will be between 9.0 million and 12.7 million tons annually. (Ref. 6.) The growth of this demand is shown in Table 2.

Table 2

PROJECTED U. S. DEMAND FOR ALUMINUM

Year	Range Million Short Tons Low	High
1972	4.8	5.6
1973	5.0	6.0
1974	5.5	6.5
1975	5.7	6.8
1976	5.9	7.5
1977	6.0	7.75
1978	6.5	8.3
1979	6.8	8.7
1980	7.4	9.0
1981	7.5	10.0
1982	7.75	10.8
1983	8.3	11.5
1984	8.7	12.2
1985	9.0	12.7

Supply of Raw Materials

In 1965 world bauxite reserves, including inferred bauxite, were estimated to be 5.8 billion tons. Potential bauxite resources were estimated to be 9.6 billion tons. The estimated world reserves of aluminum are shown in Table 3.

Table 3

ESTIMATED WORLD RESERVES OF ALUMINUM

	Millions of Tons	
	Bauxite[1/]	Aluminum Equivalent[2/]
North America		
United States		
Arkansas	44	8.8
Southeastern States	1	.2
Total	45	9.0
Caribbean Islands		
Dominican Republic and Haiti	85	17.0
Jamaica	600	120.0
Total	685	137.0
South America		
Brazil	40	8.0
Guyana	80	16.0
French Guiana	70	14.0
Surinam	200	40.0
Total	390	78.0
Europe		
Austria	1	0.2
France	70	14.0
Greece	84	16.8
Hungary	150	30.0
Italy	24	4.8
Rumania	20	4.0
Spain	7	1.4
U.S.S.R. (including Soviet Asia)[3/]	300	60.0
Yugoslavia	200	40.0
Total	856	171.2
Africa		
Ghana	290	58.0
Guinea	1,200	240.0
Mozambique	2	0.4
Malawi	60	12.0
Sierra Leone	30	6.0
Total	1,582	316.4

Table 3 (continued)

	Millions of Tons	
	Bauxite 1/	Aluminum Equivalent 2/
Asia		
China, Mainland	150	30.0
India	64	12.8
Indonesia	20	4.0
Malaysia		
Peninsular Malaysia	10	2.0
Sarawak	5	1.0
Turkey	30	6.0
Total	279	55.8
Oceania		
Australia	2,000	400.0
Palau Islands	5	1.0
Total	2,005	401.0
Total for world	5,842	1,168.4

1/ Metric or long tons, dry basis; however, many estimates used in compilation failed to designate type of tons used and whether tonnages had been converted to dry basis.

2/ Short tons.

3/ Estimate probably includes much low-grade bauxite that would be classed as potential resources in other countries and possibly aluminous rocks other than bauxite.

Source: U. S. Bureau of Mines, Mineral Facts and Problems, 1970.

The United States relies on the Caribbean area (Jamaica, Dominican Republic, and Haiti) and northeastern South America (Surinam and Guyana) for over 85% of its bauxite supply.

Table 4 projects the trends in the aluminum equivalent of imported bauxite and alumina beyond the year 1969 with actual figures from 1965-1969. In addition to these imports of bauxite and alumina, aluminum also will be imported to augment the domestic supply.

Table 4

ACTUAL AND PROJECTED IMPORTS OF BAUXITE AND ALUMINA, 1965-1985
(Aluminum content in thousands of short tons)

Year	Bauxite	Alumina	Total
1965	3,233	120	3,353
1966	3,321	259	3,580
1967	3,342	504	3,846
1968	3,166	697	3,863
1969	3,474	997	4,471
1970	3,667	1,084	4,751
1971	3,776	1,369	5,145
1972	3,879	1,644	5,523
1973	3,988	1,892	5,880
1974	4,094	2,171	6,265
1975	4,252	2,500	6,752
1976	4,335	2,620	6,955
1977	4,464	2,856	7,320
1978	4,597	3,092	7,689
1979	4,733	3,328	8,061
1980	4,874	3,565	8,439
1981	5,018	3,801	8,819
1982	5,168	4,037	9,205
1983	5,321	4,273	9,594
1984	5,480	4,510	9,990
1985	5,642	4,746	10,388

Source: Data for 1965-1975 from National Materials Advisory Board, Processes for Extracting Alumina from Nonbauxite Ores, Publication NMAB-278, National Academy of Sciences-National Academy of Engineering, Washington, D. C., December 1970, p. 9. See Appendix 2 for methodology for projection of data for 1976-1985.

Dollar Flow Attributable to Imported Bauxite and Alumina for Use in Producing Aluminum

Bauxite. The U. S. Bureau of Mines reports the United States imports of bauxite in 1969 as 12,180,000 long tons at a value of \$165,802,000 -- an average of \$13.61 per long ton. (Ref. 5.)

Alumina. Imports of alumina for 1969 are reported by the U. S. Bureau of Mines as 1,912,000 short tons at a value of \$106,333,000 -- an average of \$55.61 per short ton. (Ref. 5.)

Estimated Value of Future Imports. Estimated annual bauxite and alumina imports for the years 1972 through 1985 are listed in Table 5.

Table 5

ESTIMATED VALUE OF BAUXITE AND ALUMINA IMPORTS, 1972-1985
(in thousands)

	Bauxite (long tons)	Value	Alumina (short tons)	Value
1972	15,504	$ 211,009	3,288	$ 182,846
1973	15,952	217,107	3,784	210,428
1974	16,376	222,877	4,342	241,459
1975	17,008	231,479	5,000	278,050
1976	17,340	235,997	5,240	291,397
1977	17,856	243,020	5,712	317,645
1978	18,388	250,261	6,184	343,892
1979	18,932	257,665	6,656	370,140
1980	19,496	265,341	7,130	396,499
1981	20,072	273,180	7,602	422,747
1982	20,672	281,346	8,074	448,995
1983	21,284	289,675	8,546	475,243
1984	21,920	298,331	9,020	501,602
1985	22,568	307,150	9,492	527,850
Total	263,368	$3,584,438	90,070	$5,008,793

Note: Aluminum content figures in Table 4 converted at ratio of 1:4 for bauxite and 1:2 for alumina. Value based on 1969 average value per ton.

At 1969 value and assuming the continued dependence on foreign sources of raw materials for aluminum production, it is estimated that a total of approximately $8.6 billion will flow from the United States over the next 14 years to import bauxite and alumina.

The valuations of imported bauxite and alumina are usually F.O.B. export country.1/ Insofar as any shipments to the U. S. are made in foreign vessels, the shipping charges would constitute a further dollar outflow.

1/ Statement by U. S. Customs Agent, Classification and Valuation Section, New Orleans, Louisiana.

Chapter 4

RESEARCH NEEDED FOR A DOMESTIC ALUMINA-FROM-KAOLIN INDUSTRY

Recommended Research

In previous chapters of this report, the following facts and conclusions have been considered:

1. The consumption of aluminum in the United States and the free world is expected to grow at a rate of at least 5% annually.

2. Bauxite is the only ore of aluminum used at present in the free world for commercial production of aluminum.

3. Within eight years it is projected that 95% of the United States' requirements for primary aluminum will be imported, if present trends continue.

4. At 1969 values and assuming the continued dependence on foreign sources of raw materials for aluminum production, it is estimated that a total of approximately $8.6 billion will flow from the United States over the next 14 years to import bauxite and alumina.

5. The National Materials Advisory Board has concluded that an acid process for the treatment of domestic clay (kaolin) appears to be the most promising for the economic production of alumina from materials other than commercial bauxite.

In light of these considerations, it is concluded that there is a critical need for the development of an alumina industry in the United States based on large-quantity domestic ore sources. It is recommended, therefore, that direct full funding be allocated to be used or administered by the U. S. Bureau of Mines, in cooperation with industry, for the purpose of definitive research directed toward obtaining the best economic and technical method(s) for obtaining alumina from domestic sources of kaolin clay.

On the basis of present information, it is recommended that a nitric acid process for clay, using the best available knowledge, be tested in a 5-ton-per-day integrated pilot plant to determine if operational technology and estimated costs of operation are correct and may be scaled to a larger plant. If the 5-ton-per-day pilot plant proves technical feasibility and economic justification, it is recommended that direct full funding be allocated for a

50-ton-per-day pilot plant, with administration through the U. S. Bureau of Mines continued.

Pilot Plant Time and Cost Considerations

The recommended integrated pilot plant is projected to operate at a capacity of five tons per day of alumina product. The use of a smaller plant could decrease the accuracy in scaling up to a 50-ton-per-day plant. A minimum time period is projected as three years from the time of funding, with the possibility that three to four years may be needed. Funding for the total operation is estimated to be between \$15 and \$20 million. In terms of allocated budgeting by the Congress or executive order, it is recommended that project funding be for a total not to exceed \$20 million for four years nor more than \$8 million in any one year. This is a research rather than a testing program, and the possibility of a year's slippage due to unpredictable problems has been considered in the projected time period. Three years is the actual minimum estimated time and, if concluded in this time, funds should be allowed to apply on a 50-ton-per-day pilot plant.

The first year should include laboratory evaluation by the U. S. Bureau of Mines to determine process details and design characteristics for placing the pilot plant construction operation out for bid to industrial organizations. Bid letting based on this laboratory work is anticipated before the end of fiscal 1974, with perhaps some subcontracting or material purchases being made in fiscal 1974. The second year should see full-scale operation of the pilot plant. The third year may include some modifications and phase out of the project. It would also include recommended design of a 50-ton-per-day pilot plant and possibly costs estimates and recommendations to the Congress.

The above 5-ton-per-day pilot should give reliable figures and operating detail that will permit a tenfold scale up to a 50-ton-per-day pilot plant. Costs estimates for a 50-ton-per-day pilot plant are meaningless at present because of the number of undetermined variables. On a unit basis, however, the cost should be substantially lower. Some of the unit reduction will come from experience and some from the fact that the product should be salable. Recommendations to the Congress for funding a 50-ton-per-day plant are anticipated in fiscal 1976 or 1977.

The preceding recommendation is for a single 5-ton-per-day pilot plant using a nitric acid process on clay. This recommendation is on the basis that present knowledge, not available for the NMAB report, indicates that the technology and economics are more favorable for a nitric acid process using kaolin as the domestic material than for any other known process or domestic material excepting bauxite. Projections of cost show a nitric acid-kaolin process to be in a competitive range of the Bayer-bauxite process. Should two or more processes and/or materials be indicated as competitive by the U. S. Bureau of Mines comparative evaluations, two essentially simultaneous 5-ton-per-day pilot plants may be called for in order to document through operation the comparative costs of the two closest competing systems or materials. In this event, the Congress could be so approached for a fiscal 1975 increase in funding. In no case is it anticipated, however, that a total of more than $35 million would be needed.

Pilot Plant Process Considerations

The operating costs per ton of alumina from kaolin for nitric acid, sulfurous acid, and hydrochloric acid processes were estimated to be $58, $62, and $63, respectively, by F. A. Peters, R. C. Kirby, and K. B. Higbie in 1967. (Ref. 10.) These were based on a plant producing 1,000 tons of alumina per day. Five other processes for nonbauxite ores were also given. Most costly was a potassium-alum process at $97 per ton of alumina. Alumina from the Bayer-bauxite process was shown as $47 per ton.

In 1970 these processes were reviewed by a committee appointed by the National Materials Advisory Board, who used the same process costs as the 1967 Peters report. (Ref. 6.) They recommended small (1 to 5 tons per day) pilot plants on the nitric acid and hydrochloric acid processes for kaolin, followed by a 50-ton-per-day pilot plant based on the best process of the two smaller pilot plants. Since that time additional proprietary research has indicated that the problem of iron removal in a hydrochloric acid process may cause prohibitive costs. This then leaves a nitric acid process. The nitric acid process used for an estimate of $58 per ton of alumina was essentially the German Nuvalon process.

Energy consumption has been estimated to be approximately three times that of the Bayer-bauxite process in most kaolin-to-alumina methods. The largest energy source used in the Nuvalon nitric acid process was natural gas. Johnson (Ref. 11), Peters (Ref. 10), and the NMAB report (Ref. 6) used a cost of 2.5 cents per therm (100,000 BTU) of natural gas. Present (1972) rates in the Fall Line of Georgia area are approximately 5 cents per therm as a minimum. Cost for electrical energy in the above reports was 5 mills per kwh. The rate for electricity will depend on a combination of amount of energy and a demand factor, but will probably be between 8 and 9 mills per kwh in the Fall Line area of Georgia. The relative amount of electricity, however, is not a major cost item in the per ton costs of alumina from kaolin.

In attempting to estimate the impact of energy cost increases on the costs per ton of alumina from kaolin, it was found that different figures had been used in the energy required for steam. Total costs of natural gas (steam plus other) were given as \$15.50 by Johnson (Ref. 11) and \$12.86 by Peters (Ref. 10). When doubled, they change the estimated cost per ton of alumina from \$60.69 to \$76.19 and from \$58.05 to \$70.91, respectively. Since these figures were derived on the basis of the same costs per therm of natural gas and the same process (Nuvalon), it is assumed that the water consumption would be the same and hence the cost reduction was due to more efficient transfer of energy or a lower requirement for steam pressure and temperature. This is not necessarily correct, however, since an unpublished recent "print-out" using the same cost basis showed \$17.77 per ton of alumina for natural gas energy and changed the cost per ton of alumina from \$58 to \$75.77 per ton. The problem of the above differences in energy costs (and as they are reflected in total costs) is not that they are different, but that they are based on different estimating bases from laboratory scale experiments or computer models, each of which may have a valid assumption base. The solution appeared to be not in more estimates, but in an integrated pilot plant to obtain actual cost data on a much larger scale, as recommended by the National Materials Advisory Board.

Patent number 3,586,411, "Method for Extracting Pure Alpha-Alumina from Clays," was granted to Richard W. Hyde and Stanley V. Margolin on June 22, 1971. It has been assigned to Arthur D. Little, Inc. This process differs from the Nuvalon method in several significant ways, all of which seem to be in the direction of lowering costs. Among these are lower temperature and atmospheric pressure for leaching the clay with nitric acid with three hours residence instead of six hours, flocculation instead of settling tanks (continuous process versus 14-hour settling), removal of iron by ion exchange, fluidbed with continuous flow versus steam chambers for nitrate disassociation and removal (and with less temperature), and what appears to be an overall lower energy requirement at each significant state of processing.

A cost estimate given by R. W. Hyde (personal letter) is less than $62 per ton of alumina using current (March 1972) utility, construction, labor, mining, and overhead in Georgia. Utility costs used in this estimate were 5 cents per therm for natural gas (50 cents per million BTU) and 8.45 mills per kwh of electricity. Labor is as shown in Chapter 6. Mining cost is at $2 per ton of clay. It is interesting to note that Hyde and Margolin had an estimated cost of $39 per ton of alumina as based on 1967-1968 cost figures. As current costs were used, this was increased as follows: energy, $7 per ton; construction, $7 per ton; mining, $5.52 per ton; labor, $1.75 per ton; and overhead, $1.50 per ton, for a total increase from $39 to $61.77 per ton. A depletion of 22% to the alumina stage could reduce this to slightly more than $48 per ton of alumina.

In recommending an integrated pilot plant using a nitric acid process, the authors of this report are recommending the most efficient, lowest cost process available, to be determined by the U. S. Bureau of Mines. The Arthur D. Little (Hyde-Margolin) process appears to be the best at present, but there may be refinements or changes that may be incorporated from other workers in the field. It is hoped that the various United States aluminum and/or chemical companies who have worked on this problem will, with enlightened self-interest, cooperate with the U. S. Bureau of Mines to achieve a pilot plant operating with optimum state-of-the-art technology.

Pilot Plant Sponsorship Considerations

The recommendation for a pilot plant to produce alumina from kaolin is based on designing an integrated operation which will include all known improvements in order that they may be evaluated for a larger scale pilot and later commercial plants. Obviously this will require disclosure, permission to use, and protection of proprietary knowledge and interests. It may well take federal government action through supervision and funding to include the new technologies of diverse proprietary interests into a single integrated pilot plant. Certainly the U. S. Bureau of Mines seems the ideal agency to let contracts and supervise this operation.

Funding for the U. S. Bureau of Mines could be a problem if the Office of Management and Budget does not permit funding for this project to be over and above the regular U. S. Bureau of Mines budget. A reason for this is that the proposed annual budget for a pilot plant is equal to or exceeds the annual metallurgical research budget of the Bureau, and hence the pilot plant could, presumably, eliminate any other metallurgical research, including personnel.

There are several answers to the question of why private industry should not fully or partially fund a pilot plant. Included in these answers are the following:

1. The immediate past and present state of the economy has severely curtailed or eliminated research and venture funds of the aluminum companies. Included in this economic squeeze have been cutbacks in production, labor force, etc.

2. Research brought to an operating stage could be copied and patent litigation is expensive. Further, expenditure of company funds to help the competition is not good business.

3. Proprietary information held by several companies could be more easily used in a single pilot plant if funded by the federal government.

Reasons for U. S. government funding are the enormous values that should accrue to the nation in terms of (1) reversals of trade deficit, (2) reducing vulnerability of United States aluminum companies in foreign countries, (3) improvement of the country's strategic logistical exposure, (4) generation of tax dollars in the United States that are now going to foreign governments, and (5) improved employment within the United States both in total numbers and in contributing to the reversal of the flow of persons from rural to urban areas. These and other impacts of a domestic alumina-from-kaolin industry are considered in the succeeding chapters of this report.

Chapter 5

INTERNATIONAL IMPACT OF A DOMESTIC ALUMINA-FROM-KAOLIN INDUSTRY

A domestic alumina-from-kaolin industry would have a number of favorable impacts on the United States' international position. These may be summarized as follows:

First, it would assist in reversing the United States' increasing dependency on foreign aluminum raw materials that is projected to be 95% by 1980 if bauxite continues to be the sole source of aluminum. This reversal also will be in the direction of improving this country's balance of trade relationships and dollar deficit position, while creating new employment and taxes within the United States.

Second, it should improve business and political relationships with countries supplying the United States with bauxite and other aluminum raw materials.

Third, it would improve the U. S. military logistical exposure for aluminum.

Effect of Time on International Impact

In all of the above, time is a critical factor in determing the total impact. If allocated funds for a federally sponsored pilot plant project were to be made available by Congress effective July 1, 1973, it is anticipated that it would be 1980 to 1982 before the first commercial plant of 1,000 tons per day could be on stream. An executive order from the President of the United States could conceivably get pilot plant action sooner and would be the first place to accelerate the program.

A minimum of three years would be required from the time that funds become available for an initial 5-ton-per-day pilot plant to where sufficient documented data would be accumulated to permit design improvements to be incorporated in the development of a 50-ton-per-day pilot plant. An additional three to five years would be required (construction, operation, etc.) to have data to construct a 1,000-ton-per-day first commercial plant. Total elapsed time from first funding of a pilot plant to first commercial production is thus projected as six to eight years.

The number of companies that will enter into construction and operation of first generation commercial plants is unknown. These first generation commercial plants should also be considered as being experimental, hence a time lapse of three to five years operation should be considered as realistic before much larger scale second generation plants are feasible. When design and construction time is added, five years appears reasonable. Hence, under non-emergency conditions a time lapse of a minimum of 11 years is projected before a large-scale second generation alumina-from-kaolin plant would be constructed -- and probably 12 years before it goes on stream from time of availability of funds for a first pilot plant program. If funding were available on July 1, 1973, the beginning of more substantial alumina production from Georgia kaolin could not be expected before 1985. This is five years after the projected time that only 5% of the U. S. annual requirement of aluminum raw materials will come from domestic bauxite. Acceleration possibilities are (1) a quicker start by presidential executive order and/or (2) acceleration by commercial plants after the second pilot plant.

U. S. Balance of Trade

A substantially improved position in the United States' balance of trade resulting from a domestic alumina-from-kaolin industry is not expected to be forthcoming until second or later generation plants come on stream. The projected impact between 1980 and 1985 in dollar flow reversal should be on the order of $78 million total for four years for each 1,000-ton-per-day alumina plant, provided a pilot program is started in early 1973. While this is not impressively large in view of the $2,991 million estimated value of aluminum source imports during the four-year period 1981-1984, it must be evaluated in light of the fact that this is production from experimental plants versus much larger scale plants that should follow.

The recommendations for low-cost loans and investment credits (see "Conclusions and Recommendations" section of this report) are for the purpose of accelerating industry action to obtain substantial domestic production of alumina from kaolin. Using projected annual data in Table 5, value of 1985 imports of bauxite and alumina is projected as $835 million. Annual domestic trade reversal to 25% to 50% of this, say during the period 1985-1995, obviously would have a substantial favorable economic impact for the United States.

Relationships with Source Countries

The improvements of the negotiating position of the domestic aluminum companies is considered to rank high -- if not first -- as an immediate and long-range impact of a domestic alumina industry.

In light of growing nationalization in many countries where United States companies are mining bauxite, the continued dependence on bauxite as the sole source of raw material for aluminum leaves U. S. industry vulnerable not only in negotiating new agreements in foreign countries but in preserving the integrity of old agreements. Expropriation may not take place, but the temptation of expropriation and of creeping encroachment of management and profits is magnified by the lack of domestic sources if bauxite alone is considered.

In regard to the problem of foreign aluminum sources for the United States, the strong possibility of using domestic aluminum sources should have an immediate salutary impact on relations with existing source countries. A pilot plant and eventual commercial production could serve as a deterrent of consequence in abuse of overseas aluminum source negotiations. It is anticipated that foreign sources will be used for years to come, even with a domestic source industry.

If the expenditure of $20 million by the federal government for an alumina-from-kaolin pilot plant prevented expropriation in one instance, it would have paid for itself many times over in terms of capital investment of United States funds, loss of profit source, loss of commodity source, and loss of taxes -- not to mention loss of prestige.

U. S. Strategic Logistical Exposure

In addition to the above economic considerations, another important element of concern is the fact that the imported aluminum raw materials move to this country by water. In view of a projected 95% import dependency by 1980 if bauxite alone is used as a source of aluminum, the strategic logistical exposure of the United States could become acute.

Stockpiles of aluminum, alumina, and bauxite are maintained. The size of these stored resources are governed by the logistical expertise and prediction capability of the federal government, the economics of storage, and the nation's economy.

It is not possible to predict the likelihood or possible duration of a military conflict in the future. Some feel that if an armed conflict were to occur between the United States and another major nation it would be short lived because of nuclear warfare and that present stockpiles of materials would be more than adequate. On the other hand, technologies of wars are frequently unpredictable. To this end, there are schools of thought that do not believe the nuclear bomb would be used -- certainly not initially. A long war, dock strikes either here or abroad, or other unforeseen circumstances could deplete or seriously reduce the United States' stockpiles of aluminum and strategic raw materials.

Chapter 6

IMPACT OF A DOMESTIC ALUMINA-FROM-KAOLIN INDUSTRY ON EMPLOYMENT AND REVENUE

The purpose of this chapter is to identify the estimated manpower requirements, special skills needed, potential wages, and economic impact of the new jobs that might result from the establishment of each 1,000-ton-per-day commercial alumina plant for producing alumina from kaolin in Georgia. A nitric acid process will be used as a basis for analysis, since the estimated cost per ton is the most promising of many processes considered by the project team. The estimated cost of $61.77 per ton of alumina for the Hyde-Margolin process includes comparable labor costs as shown herein.

Background

To date, the nitric acid process for producing alumina from clay has only been done in the laboratory. No company or government agency is known to have established or operated a nitric acid integrated processing facility. However, it has been recommended by the National Materials Advisory Board that integrated pilot plants be established for use of clay (kaolin) for the production of aluminum. The report from this Board states, "The most likely areas where clay containing approximately 35% alumina and in deposits of 50 million tons or more can be considered available for aluminum are: (1) the Georgia-South Carolina kaolin belt in which deposits are of Cretaceous age; (2) a belt of Eocene Age deposits which includes the Andersonville district, Georgia, and extends northeast and southwest of this area; and (3) the Arkansas bauxite region." (Ref. 6.)

During the past 30 years much laboratory research and evaluation has been done to develop methods, techniques, and processes for extracting alumina from kaolin suitable for aluminum production.

Personnel at the College Park Metallurgy Research Center, Bureau of Mines, College Park, Maryland, have performed laboratory research and evaluation and have compiled a large amount of data on the Nuvalon nitric acid process. They have also developed a computer program to calculate capital and operating costs from material and energy requirements and equipment costs for use in preparing cost estimates for metallurgical process, manufacturing, and evaluation. Since ongoing laboratory research evaluation has continually changed the nitric acid process, the Center's computer program permitted its users recalculation of processing costs when changes of data or equipment made this desirable.

Estimated operating costs were based on a 350-day year, 24-hour-per-day operation, allowing 15 days downtime for inspection, maintenance, and unscheduled interruptions.

The direct labor costs for the nitric acid process were estimated on the basis of manning the plant with 4.2 employees for each job that operates 24 hours per day, 7 days per week, and 1.4 employees for each job that operates 8 hours a day, 7 days a week.

Based upon data provided by the evaluation group, estimates were made of the manpower requirements, special skills needed, potential wages, and economic impact of the new jobs that might result from the establishment of a 1,000-ton-per-day nitric acid processing plant for producing alumina from kaolin in Georgia.

Manpower Requirements

Estimated manpower requirements for operating a 1,000-ton-per-day nitric acid facility are summarized as follows:

Number of Employees	Type of Job	Skill	Rate of Pay	Annual Payroll Dollars
118	Plant Production Workers	Semiskilled to highly skilled	$3.70 per hr.	$ 908,100
14	Plant Production Supervisors (the above includes clerical help)	Skilled	4.70 per hr.	136,200
55	Plant Maintenance Workers	Highly skilled	6.30 per hr.	724,800
9	Plant Maintenance Supervisors (the above includes clerical help)	Highly skilled	7.75 per hr.	145,000
1	Plant Manager			30,000
1	Assistant Plant Manager			20,000
1	Secretary			7,000
1	Receptionist			5,500

Number of Employees	Type of Job	Skill	Rate of Pay	Annual Payroll Dollars
4	Engineers			$ 64,000
1	Draftsman			8,000
1	Chemist			18,000
2	Laboratory Technicians			16,000
2	Safety Engineers			28,000
12	Plant Guards and Firemen			90,000
1	Chief Accountant			19,000
1	Senior Accountant			14,000
2	Clerks			12,000
1	Secretary			7,000
1	Purchasing Manager			15,000
1	Secretary			6,500
1	Marketing Manager			15,000
1	Secretary			6,500
2	Loader Operators	Skilled	$3.70 per hr.	15,390
12	Truck Drivers	Skilled	3.70 per hr.	92,350
3	Equipment Preventive Maintenance Workers	Semiskilled	3.00 per hr.	18,220
2	Motor Grader Operators	Skilled	3.70 per hr.	15,390
2	Mining Supervisors	Skilled	4.70 per hr.	19,950
252	Total			$2,457,300
	Payroll Overhead (Fringe Benefits) Includes vacations, pensions, workmen's compensation, insurance, holidays and other fringe benefits.			669,900
	Total			$3,127,200

In addition to the 252 or more direct new jobs created by each 1,000-ton-per-day commercial project, it is expected that 1,000 additional indirect jobs (1:4 ratio) will be created in order to supply the commercial facility and its employees with essential services. This includes heavy equipment maintenance and suppliers of processing chemicals, power, water, gas, communications, and education.

Jobs related to construction of plants are another source of employment that will result from an alumina industry.

Special Skills

Manpower required to operate and maintain an alumina plant will need to be semiskilled and skilled labor with relatively few unskilled workers. Highly skilled technicians will function in the areas of chemical analysis, servo-mechanisms (both mechanical and electrical), and exotic materials fabrication. However, a majority of the employees will be classified as semiskilled and skilled.

Employment Impact

It is difficult to identify the total employment impact the proposed new commercial plant will have on the area, Georgia, the Southeast, and the United States as a whole. However, it is clear that the proposed new facility will establish a new basic industry in Georgia. It will provide new jobs during the construction period. It should provide a minimum of 252 direct new jobs and 1,000 indirect jobs. It should result in minimum annual payroll increase of $2,457,300 plus $669,900 in fringe benefits.

It is also apparent that this new basic industry will have the immediate and long-range effect of providing training opportunities and expanding employment opportunities for the low skilled, unemployed of the area, and enhancing their standards of living.

State and County Revenues

According to the Georgia Department of Revenue, total tax revenue amounted to $100 per $1,000 of personal income in Georgia for 1971. Personal income is defined as income reported by all employees and individuals from all sources. Total tax revenue is defined as all payments derived from the application of local and state tax regulations. State and local taxes collected per $1,000 of personal income for 1971 is presented in Table 6.

Based on this information, it is estimated that the annual tax revenue derived from an alumina plant operating in Georgia would amount to over $245,000 ($2,457,300 payroll x $100 ÷ $1,000 = $245,730).

Table 6

TOTAL TAX REVENUES COLLECTED PER $1,000 OF PERSONAL INCOME BY CATEGORY

Category	Tax Collected
Property	$ 31.00
Sales and Use	20.00
Income	12.50
Corporate	6.25
Other 1/	30.25
Total	$100.00

1/ Other taxes include cigarette, liquor, motor, fuel, highway use, estate, etc.

This estimate is considered to be conservative because the $100 per $1,000 of personal income is based on total personal income and taxes received in Georgia for 1971. It should be noted that capital investment required to establish an alumina facility will exceed $50 million and consequently will generate far more taxes than the average taxes paid by Georgia industry. Projections have been on a conservative $50 million, but industry sources have indicated that construction costs could be more than double this figure.

A closer estimate of state and county tax revenues that could be derived from the location of a $50 million plus alumina plant in Georgia is best obtained by applying the current tax regulations to the estimated value of land, buildings, equipment, and inventories. Taxes derived from corporate income tax and individual income, property, and sales taxes can also be estimated by applying the pertinent tax regulations to average income estimates and aggregate payroll data. The following method for estimating annual taxes and revenues assumes:

1. An average of 25 mills throughout the Georgia kaolin belt;
2. A 40% assessment ratio as prescribed by state law; and
3. An item value on an estimated cost basis.

Table 7 presents the estimated annual taxes which could be derived from the location of an alumina plant in the Georgia kaolin belt utilizing the above method.

Table 7

ESTIMATED ANNUAL STATE AND COUNTY TAXES FROM ALUMINA PLANT IN GEORGIA

Item	Value	Assessed Value	Taxes
Land and Buildings	9,300,000	3,720,000	$ 93,000
Equipment	40,746,000	16,280,000	407,460
Inventory (one month supply of raw and process materials)	1,944,000	777,000	19,440
Employee			
State Sales Tax (Personal Expenditure) $150 annually x 252 employees1/			33,768
Income Tax $100 annually x 252 employees2/			25,200
Property Tax			
$2.5 million payroll x $31 ÷ $1,0003/			77,500
Corporate Income Tax			N/A
Total			$656,368

1/ From 1971 Optional State Sales Tax Table of the Federal Income Tax Form published by the Department of Treasury, Internal Revenue Service, and based on a family of four with an annual income of $9,751.

2/ Based on a family with two adults, two dependent children, and 10% standard deductions, with an average annual income of $9,751.

3/ Georgia 1971 Statistical Report, State Department of Revenue, Chart 8, p. 14, December 1971.

N/A - Not available.

Because tax regulations allow a minimum 5% annual depreciation of fixed assets, the tax liability of the alumina company will decrease $25,000 annually. However, as new equipment is purchased to replace worn out and depreciated equipment, the annual tax liability will be adjusted to reflect the new values.

Federal Revenue

The Internal Revenue Service has estimated the individual income tax paid by Georgia workers to be \$1.5 billion. The Office of Business Economics has estimated the personal income of all Georgia residents to be \$14.3 billion. These two statistics indicate that approximately 11% of personal income in the state of Georgia is paid as federal income tax.

The proposed alumina facility would have an annual payroll of approximately \$2.5 million dollars, of which 11% would be paid as federal personal income taxes. This would amount to \$275,000 annually.

In summary, it is difficult to quantify all of the local, state, and federal revenues which would be derived from the proposed alumina facility. However, it is evident that Georgia could expect to receive over \$600,000 in new revenues and the federal government, \$275,000. There are other federal taxes not estimated here which would increase the above figures. Examples of such taxes are excise, lubricating oil, gasoline, etc.

Chapter 7

IMPACT OF A DOMESTIC ALUMINA-FROM-KAOLIN INDUSTRY ON THE CURRENT KAOLIN INDUSTRY

The estimated impact on the current kaolin industry of an alumina (Al_2O_3) industry using kaolin as an ore must be based upon the size of the new industry. The principal guides to size used in this estimate are (1) a minimum size commercial kaolin-to-alumina plant of 1,000 short tons of alumina per day and (2) the present and predicted use of aluminum in the United States to obtain an estimated maximum United States alumina requirement. For purposes of estimating, a 30% recovery of kaolin as alumina (averaging 35% Al_2O_3) and a 2:1 alumina to aluminum recovery has been used. Actual aluminum from alumina is 52.9% instead of 50%. Other estimating bases are also considered conservative.

Projected Demand for Kaolin

A 1,000-ton-per-day alumina plant would produce 350,000 short tons of alumina and consume 1,167,000 short tons of kaolin in a year, or roughly one-third of the 1970 Georgia kaolin production.

The National Materials Advisory Board report projects domestic demand in 1985 to be between 9 and 12 million tons of primary aluminum or 18 to 24 million tons of alumina. (Ref. 6.) If 25% of the projected demand were to be met by Georgia kaolin, the annual kaolin requirement would be approximately four times 1970 annual Georgia kaolin production for the lower figure or approximately 5.3 times if the larger figure is correct. The 1970 production of kaolin was 3,749,000 short tons. (Ref. 12.)

Unless accelerated, however, the program proposed in this report does not anticipate second generation commercial plants to go on stream before 1985. A single first commercial plant of 1,000 tons of alumina per day at 350 days per year is only 350 thousand short tons of alumina instead of 4.5 million to 6 million tons that would be projected at 25% of demand. Kaolin requirements for alumina could thus be projected to approximately one-third of 1970 production for each 1,000-ton-per-day alumina plant. In the period 1970-1985, kaolin production for present uses is predicted to rise two to three times 1970 production, or between 7 and 12 million tons. (Ref. 3.)

Impact Possibilities

Obviously, usage of kaolin for alumina until 1985 -- or until second generation plants come on stream -- will have relatively little impact. Second generation plants, if after 1985, could double to quadruple demand if based on 25% to 50% of domestic supplies of aluminum raw materials being met from this source. Based on the above, there emerges several tangible possibilities regarding the impact on the kaolin industry by an alumina-from-kaolin industry.

1. Based on predictions of increased demand for kaolin, whether before, by, or after 1985, there should be much greater competition for reserves. If, as the kaolin industry states, large blocks of reserves are under 50 or more year leases or owned in fee simple by kaolin companies, that competition could take place more at the corporate level than the non-industry landowner's level. This could escalate prices but obviously not to the extent of pricing out of the market. Acquisition of reserves could be by joint ventures between kaolin companies and aluminum companies, purchase of large blocks of leases by aluminum companies, or leases or subleases.

2. There should be an impact on the labor market. A skilled manpower shortage could develop temporarily, coupled with an increase in cost of labor; but there should be, in the long run, a more stable labor force.

3. The demands of the aluminum industry would put a preminum on large deposits of kaolin that could be readily mined in close proximity to the processing plant. Selective mining and selective transportation of grades of kaolin would probably not be economically permissible. This, in turn, would require protection of the high value clays for present uses such as for paper. A question arises concerning reserves for each. The impact here would be to stimulate better knowledge of the reserves through research. This also would be required for better planning.

4. There would be an impact on the tax digest that should help the kaolin companies.

5. Required new power, transportation, and other supply sources could benefit the present kaolin industry.

6. The current nitric acid processes are expected to utilize kaolins that are currently off-grade and hence would favor use of clays that are rejected for present and possible future market use. Therefore, it should

permit disposal of large tonnage reserves of clay of questionable use by the kaolin industry. The impact on the kaolin companies would be in their favor and put them in a much better capital position for research and expansion.

7. Present laws for environmental rehabilitation of mined areas and elimination of air and water pollution will be realistically examined.

8. The expected use of large amounts of process water may result in more water control.

9. By-product SiO_2 from the leaching operation could offer competition as a pigment or filler to "air-float" kaolin.

Chapter 8

SATELLITE INDUSTRIES AND THEIR IMPACT

The types and impact of satellite industries and services that would be required for an alumina-from-kaolin industry must be based on the primary raw materials, production steps, and products. The primary raw materials are kaolin, acid, and water.

Mining Supplies

Kaolin mining itself should not create new satellite industries for supply, as the requirements are mostly those of excavation and mine-to-plant transportation. Services for such mining in terms of repairs are currently conducted by the mining company or the equipment supplier. In the event the alumina-from-kaolin industry should grow to where it would supply a major portion of alumina for domestic use, it is likely that service companies would be created for the industry. In essence, it is a matter of size.

Acid Supplies

If a 1,000-ton-per-day alumina plant were built using nitric acid, a large amount of the acid would be recovered. New supply acid could be on the order of 65 tons per day, or two or three tank cars. It is not likely that a new separate acid plant would be built. More likely would be the use of a supplement to the existing plant using anhydrous ammonia to supply the input to make the required nitric acid.

On the same basis as above, a hydrochloric acid process would probably also ship in its acid requirements. To put it more succinctly, 80 rail cars of alumina product a week will not support a minimum size acid plant.

Transportation

Should three to five plants with an average capacity of 500,000 tons per year of alumina be established, the cumulative output of 1.5 million to 2.5 million tons per year would have considerable effect. At the minimal output of 1,000 tons per day, 80 hopper cars per week would be required to transport the weekly production. A maximum of 556 cars per week would be required to transport 2.5 million tons per year. In making these estimates, a hopper car with a 90-ton capacity was used. The actual number of cars required would be greater than the weekly requirement and would depend on the cycle time of load, transport, dump, and return. The transport factor in terms of distance/time would govern the number of cars in addition to possible back-haul freight.

At this time rail commodity rates for alumina do not exist in the kaolin belt. As a matter of course these rates must be established. The railroads have expressed desire to work with any party desiring to obtain more definitive information.

The four rivers of the area provide a possible transportation mode, but at this time these rivers do not have the necessary channel depths. Should these rivers be developed, the transportation of alumina by barge would be a very real possibility. A majority of the aluminum producers are located on large rivers or have access to port facilities for loading and unloading barges.

The direct effect on the highways is considered negligible. However, the indirect effects due to the economic impact could be considerable. Production plants are staffed with people, and highways transport people and all of the goods and services they require.

Water

A major need for an alumina plant is water. No satellite or service industry is forseen for this, but the hydrology of the area and the environmental and ecological impact must be worked out.

Energy Sources

In addition to raw materials, approximately 103,000 kwh of electrical power will be required per day, as calculated from U. S. Bureau of Mines data on the 1,000-ton-per-day nitric acid Nuvalon process. (Ref. 12.) This new load of electrical service may require new sources. New sources obviously will be required when production moves from experimental to major plants.

Energy for processing will require a large supply of natural gas, coal, or crude oil. For 1,000 tons or more per day of alumina, oil would probably come by rail. In the event of major growth, oil would probably be piped. Coal would be expected to come by rail. The presence of hydrocarbons and acids possibly could lead to satellite chemical production but is viewed as remote under projected conditions. The location of hydrocarbon and acid plants on the Altamaha or Savannah Rivers would enhance this possibility because of the availability of large amounts of water for cooling and processing. The possibility of water transportation is also a consideration.

Alumina-using Industries

The more likely satellite industries will be those using alumina per se. These are listed under the general headings of abrasives, chemical and allied products, and non-clay refractories. Domestic production of these products is predicted to increase three to sixfold by the year 2000. They could be a natural outlet for an alumina industry with or without a major use for aluminum. Satellite industries using alumina would bolster the economy and labor index because of their requirements for skilled and trained labor. Other satellites could be those using the SiO_2 resulting from leaching of kaolin.

Aluminum Reduction Plants

Assuming the continued use of the Hall-Heroult processing method, the location of new aluminum reduction plants will need to be where relatively low-cost electricity is available -- and not necessarily near sources of alumina. The possibility of low-cost electricity from nuclear power plants of more advanced design could make it advantageous to locate some future reduction plants in the area where alumina would be produced, which in turn could lead to an integrated operation including products made of aluminum. In projections to the year 2000, this should be considered a possibility for Georgia, particularly in light of the following projections for nuclear fusion plants made by the Atomic Energy Commission (Ref. 13):

Demonstration of scientific feasibility by 1976 to 1979;
Operation of at least two prototypes by 1980 to 1984;
Operation of at least one demonstration plant by 1990;
Sales of fusion reactors on a commercial basis by 2000.

Such growth as projected could also mean that sources other than kaolin, such as alunite in Utah, also could come into production as domestic competition to kaolin in supplying the United States aluminum industry.

Chapter 9

ENVIRONMENTAL IMPACT OF A DOMESTIC ALUMINA-FROM-KAOLIN INDUSTRY

The first purpose of this chapter is to identify as many factors as possible that could change the environment if an alumina-from-kaolin industry were to become a reality in Georgia. If factors may be projected as harmful to the ecology or total environment, corrective measures will be recommended for pilot plant testing. Other factors about which insufficient knowledge is available, both as to the factor or its effect, are recommended as part of the research to be included in the pilot plant operation, both for more definitive identification and for remedial testing where indicated.

Mining

Mining would be open-pit or surface mining, sometimes called strip-mining. In the past, kaolin mining has been an eyesore and a detriment in that little if any effort was made to reclaim mined land. This has changed drastically in recent years. Reasons for reclaiming land include the following considerations:

1. The growing public concern over misuse of natural resources enhanced the possibility of restrictive state or federal mining laws on one hand, and better public relations could be achieved on the other.

2. The realization that on a short-term basis it was more costly to reclaim land, but on a long-term basis there was the possibility of it being profitable. Long-term profit could be predicted because (a) increase of land values (provided land was usable) could be predicted on population projections; (b) reforestation and timber farming could be profitable; and (c) recreation areas (fishing ponds, hunting preserves, etc.) could be developed.

The State of Georgia now has surface mine laws that require prior approval for any surface mining.

It is believed that mining of kaolin for its alumina content should not be an environmental or ecological problem because the legal and technical means to enhance the resulting surface and improve the environment are well under way.

In addition to consideration of the land surface before and after mining, the hydrology of mined areas must also be a consideration in the location of each mine site. This will vary from site to site, but of principal interest will be whether or not there will be a negative effect on any down-dip aquifers. A hydrologic study should be mandatory in order that this aspect of the environment may be considered before permission to mine is granted. This may be much more important when some of the thicker and deeper "grey clay" deposits are mined as contrasted to thinner and shallower beds of kaolin of past and present mining.

Another hydrologic consideration in large-scale mining would be the effect on the local water table. Again this should be on a check list of considerations prior to mining as conditions will vary from site to site. Additional hydrologic considerations are given in later sections of this chapter.

In actual mining, emissions from power equipment should be kept minimal. Federal and state regulations will probably establish acceptable standards by the time mining becomes substantial. Mine-to-plant transportation will probably be a covered or enclosed conveyor belt system operated by electric motors. Enclosure would prevent disintegration of clay nodules during periods of heavy rainfall, etc. A closed conveyor system should not be a negative environmental factor.

Processing

Environmental considerations in the processing operations will follow the flow sheet shown in the Hyde and Margolin-Arthur D. Little patent. The chief detrimental possibilities will, in varying degree, be the same for any nitric acid process.

Calcining. The clay will be fed into a rotary kiln where it will be calcined at 700° to 800° centigrade (1292° to 1562°F) to remove all water, including water of composition. Pollution possibilities are dust, fuel oxides (CO_2, etc.), thermal pollution, and water as steam. State-of-the-art methods exist to deal with each of the above pollution possibilities, including recovery and reuse of the water after condensation.

Leaching. Leaching will be approximately at 125°C (257°F) with a 95% to 100% stoichiometric amount with a concentration of 35% to 55% by weight of nitric acid. Pollutants here could be escape of HNO_3 or fumes of same. Proper design and maintenance should eliminate this. Some heat carry-over of the solids from calcining and of the acid from the regeneration in the fluid-bed and heating step is anticipated.

Flocculating and Separating Solids. The chief environmental consideration will be the disposal of solids remaining from the leaching. The solids will be composed primarily of flocculated silica and sand or grit that remains after nitric acid has removed the alumina from the calcined clay. Clay particles are on the order of a micrometer (micron) in size, and their leached remains should be on the same order of size. One consideration has been that this material could be included in the "fill" of land reclamation, but it will require some experimentation to find the optimum way of doing this. The first pilot plant should give sufficient opportunity to make this determination. Use of the silica as a by-product is also a probability, and it is suggested that research directed toward by-product uses of the silica be explored. As an example, the silica should be investigated concerning its use as a pigment, filler, molecular sieve material, abrasive, source of silicon, source of water glass, and/or other uses.

Ion-Exchange Removal of Iron and Other Metals. In this process the principal exchange or stripping liquids are purified and recycled. Trace HNO_3 and HCl in the ion-exchange media are removed by separate water washings. A separate process has been developed to recover the HCl for recirculation and to recover the iron as a high density Fe_2O_3 product. In each of the steps through this one, there has been a stepwise decrease in process temperature, so that thermal pollution is minimized by more gradual dissolution. Further this stepwise decrease has permitted preservation of energy in the process and is in the direction of lowering costs.

Heating in Fluidized Bed. This step requires the reintroduction of substantial energy. Even if natural gas were to be used for initial calcining of clay, coal could be used effectively at this step. Heat of the product in this step is essentially transferred to the next step and further increased. Part of the heat is taken up in an endothermic process reaction of separating the nitrogen oxides from the aqueous aluminum nitrate feed, and part in converting water present to steam and nitric acid. Some thermal pollution could be present but is expected to be minimal as this hot aqueous acid would be circulated hot back to leach the clay.

Care in design, operation, and maintenance should eliminate nitrate pollution as acid or fumes. Recovery of the nitrate as hot HNO_3 for recirculation to clay leaching is part of the lowered economics of the process as both acid and heat are conserved.

Stack exhaust, gaseous or solid, must be dealt with. Solid wastes such as coal ash must be recovered. Fly ash disposal as a salable product or mine fill should be considered. Gaseous products of fuel consumption such as SO_2 and CO_2 should have adequate technology for control by the time a 1,000-ton-per-day plant is established. Best present technology should be applied to pilots for exhaust and fume control.

Heating to $400^{o}C$. The problems here have been covered in the previous step.

Calcining to Alpha-Alumina. Less input energy is required because the reaction is exothermic. Exhausts and fumes have been previously covered. Heat dissipation from the product that has been heated to $1000^{o}C$ must be dealt with. Energy transfer from the product to one or more of the preceding steps should be sought. Some thermal pollution appears likely. Control within reasonable limits is necessary. Dust elimination or control is mandatory. Transfer of the cooled dry product to storage or shipment in covered hopper rail cars should also have adequate dust control and recovery.

Other Considerations

Water Supply and Wastes. This process uses substantial amounts of water, but the water, as well as other fluids, is recovered and recirculated in most instances. New water needed is then greatly reduced. Even cooling water or liquids seem to be minimized due to the stepwise reduction of the temperature of process fluids and the resulting conservation of energy. Radiation of heat obviously will accomplish some of this reduction of temperature. Again, this is one of the needs of an integrated pilot plant to check design and operating characteristics. Waste water will probably be sent to ponds for treatment, recirculation, or return to natural form.

It is recommended that hydrologists of the U. S. Geological Survey work with personnel of the U. S. Bureau of Mines and state officials in determining the hydrologic impact of an alumina-from-kaolin industry. This would include considerations discussed under mining.

Population. Projected population increases will also require new sewage disposal systems, additional water sources, and other community services which good planning can prevent from becoming environmental problems. Planning and implementation for increase in community size should go hand-in-hand with pilot plant operations.

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APPENDICES

Appendix 1

The following is quoted, with permission, from Processes for Extracting Alumina from Nonbauxite Ores, a report of the Panel on Potentials of Aluminum Extractive Processes of the Committee on the Technical Aspects of Critical and Strategic Materials, National Materials Advisory Board, Division of Engineering - National Research Council, Publication NMAB-278, National Academy of Sciences - National Academy of Engineering, Washington, D. C., December 1970, pp. 1-3.

I. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

A. An acid process for the treatment of clay appears the most promising for the economic production of alumina from materials other than commercial bauxite. The available experimental and pilot plant data for producing alumina from clay appear sufficient to conclude that most of the alkaline processes normally cannot compete economically with acid processes.

Except for meeting the acceptable industry maximum of 0.03 percent Fe_2O_3, the technical feasibility of producing reduction-grade alumina by the hydrochloric extraction from clay has been demonstrated on a small scale. Probably, there would be significant economies in a production plant of large tonnage. This and other economic factors cannot be evaluated except by relatively large and extensive pilot-plant testing.

This Panel recommends that, to obtain comparative figures on the viable acid processes, the Bureau of Mines, with the financial help and cooperation of the domestic aluminum producers, (1) choose a specific HCl process for producing alumina from clay and build and operate a pilot plant of from 1 to 5 tons per day, and (2) select a nitric acid process for producing alumina from clay and build and operate a pilot plant from 1 to 5 tons per day. Hopefully, all of the producers would find it to their advantage to participate.

If the results from either of these pilot plants are successful, a larger pilot plant of 50 to 100 tons per day should be built to obtain the data necessary for scaling up to commercial plant size.

B. Another source of alumina worthy of consideration and more research is the dawsonitic [dawsonite-$NaAl(OH)_2CO_3$] deposits associated with oil shales in the Colorado-Wyoming-Utah area. The large quantity of this potential domestic source of alumina and oil is sufficient incentive to continue the current investigations by the Bureau of Mines and others for more general information and better extractive methods. However, at the present state of technology, a great part of the commercial value of the dawsonitic shales might be lost if nuclear in situ processing were conducted on them.

The Panel recommends that the Bureau of Mines expand its present research program on dawsonite. The program should include detailed mineral surveys of the extent and value of the deposits, the technical variables affecting various recovery processes, and the economics of alumina production in relation to both the sodium and the associated oil industries.

C. The production of alumina from aluminum phosphate rock does not appear economically feasible even if P_2O_5 were recovered as a by-product. Only increased return from potential additional by-products, such as uranium and cement ingredients, could change the economic outlook.

D. The production of alumina from anorthosite does not appear economically practicable using present technology because of the high processing costs.

E. The recovery of alumina from copper leach solutions may prove economic but does not represent a potentially large source of supply.

F. Today, insufficient information is available to evaluate saprolite or aluminous shale as potential domestic sources of alumina. Very large tonnages of aluminous saprolite exist and could be strip mined after removal of a thin layer of soil. Although aluminous shale is inexhaustible, no action is recommended presently on this source.

G. The quantities of ash generated at any one place are insufficient to be considered as a raw material of aluminum. Future restrictive requirements on atmospheric pollution might reduce further the amount of ash generated at localities where aluminous raw material would be desired. The use of coal ash as a source of alumina also may be lessened by the following: (1) the wide range of alumina contents of ash make raw material quality control difficult or costly and (2) much coal ash has been so vitrified that the alumina present is in a relatively insoluble form.

H. Alunite has little potential of being a major raw material of aluminum in this country because all known deposits are either small and scattered or have the mineral disseminated through volcanic rock. Alumina extracted from such material would not be competitive in price.

I. To date, none of the new reduction technologies which have been developed -- including direct reduction -- have been attractive economically.

J. The electrolysis of aluminum chloride, based on current attempts, is unlikely to compete successfully with the Hall process. Future technological advances in materials of construction might permit a different conclusion.

Appendix 2

METHODOLOGY FOR IMPORT PROJECTIONS

To establish dollar flows attributable to bauxite and alumina imports, it was necessary to project through 1985 the imports of bauxite and alumina. Sources of data were primarily the Mineral Yearbook (1969) and Mineral Facts and Problems (1970), both published by the U. S. Bureau of Mines, and Processes for Extracting Alumina from Nonbauxite Ores, a report of the National Materials Advisory Board (1970). The data shown in Appendix Table 1 were analyzed by

Appendix Table 1

ACTUAL AND PROJECTED IMPORTS OF BAUXITE AND ALUMINA, 1965-1975
(Aluminum content in thousands of short tons)

Year	Bauxite	Alumina
1965	3,233	120
1966	3,321	259
1967	3,342	504
1968	3,166	697
1969	3,474	997
1970	3,667	1,084
1971	3,776	1,369
1972	3,879	1,644
1973	3,988	1,892
1974	4,094	2,171
1975	4,252	2,500

Source: National Materials Advisory Board, Processes for Extracting Alumina from Nonbauxite Ores, Publication NMAB-278, December 1970, p. 9.

fitting linear and non-linear functions to determine which curve best fit the data. The following equations fitted to the data were chosen for use in the estimation of imports of bauxite and alumina in aluminum equivalents:

Bauxite

$$y = 468.118\, e^{.02929x}$$

y = imports of bauxite in aluminum equivalent

x = year; where 1965 equals 65

$$R^2 = .933$$

Alumina

$$y = -15328.1 + 236.164x$$

y = imports of alumina in aluminum equivalent

x = year; where 1965 equals 65

$$R^2 = .993$$

A-1458

ALUMINA from KAOLIN

Industrial Development Division

ENGINEERING EXPERIMENT STATION

Georgia Institute Of Technology

Project A-1458

ALUMINA FROM KAOLIN

Prepared for
Georgia Department of Community Development
Under a Grant From
The Coastal Plains Regional Commission

by
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and
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Industrial Development Division
ENGINEERING EXPERIMENT STATION
Georgia Institute of Technology
November 1974

Table of Contents

INTRODUCTION

Purpose of Report

The primary purpose of this report is to provide environmental guidelines through a compilation of relevant environmental regulations that must be considered in determining the feasibility and planning for the development of an alumina-from-kaolin industry in Georgia.

Environmental considerations must be an integral part of any new technology and hence must be a part of industry's planning. The need, therefore, for environmental guidelines for planning and operation of an alumina-from-kaolin industry in Georgia has been apparent. The strong possibility of the development of an alumina-from-kaolin industry in the state within the next 10 years or less is an added incentive.

The first section of this report covers a general overview of the State of Georgia's environmental authorities and procedures. Laws and regulations relating specifically to mining and to the various processing operations involved in the extraction of alumina from kaolin are detailed in the remaining sections.

Previous Alumina Studies

In April 1972 the Industrial Development Division (now the Economic Development Laboratory) of the Engineering Experiment Station at the Georgia Institute of Technology prepared a report entitled Alumina from Kaolin Potentials for the Georgia Department of Community Development (then called the Georgia Department of Industry and Trade).

The 1972 report concluded that the use of bauxite as the only primary source of alumina and aluminum placed the United States in a vulnerable position concerning supplies of this important metal.

The problem was not that the United States lacked adequate sources of aluminum-bearing minerals. The problem had been the economic advantage of the technology of using bauxite versus the economics of technologies of other aluminum-bearing minerals.

The question was what was to be done and how to proceed in implementing an economically competitive, self-sufficient domestic alumina-aluminum supply. The action recommended in the 1972 report was directed toward giving answers to this question.

In November 1974 the Industrial Development Division prepared another report for the Georgia Department of Community Development which addressed the validity of the conclusions drawn and recommendations made in 1972, recounted events that had occurred between 1972 and 1974 which reinforced or warranted changes in those conclusions and recommendations, and discussed new items which influenced recommendations made in the 1974 report.

Among the conclusions drawn in the 1974 report was that the projected relative economics, based on new construction, indicated that bauxite and kaolin as a source of alumina were nearly even. Lead time, however, for testing and constructing an alumina-from-kaolin facility would be at least five years -- and perhaps more. Another conclusion reported in the 1974 study was that technology was considered to be available to satisfy the environmental considerations of an alumina-from-kaolin industry.

Progress in Extractive Methods

At the present time, there are at least three acid extraction methods that may be used to produce alumina from kaolin. The methods are (1) nitric acid, (2) hydrochloric acid, and (3) concentrated sulphuric acid-hydrochloric acid. Each of the acid extraction methods is under serious consideration by one or more aluminum companies. There has been pilot work on nitric acid and there is pilot work on a hydrochloric acid method in progress at the U. S. Bureau of Mines' Metallurgy Research Laboratory in Boulder City, Nevada. The concentrated sulphuric acid method with a hydrochloric acid purification step has been piloted at a miniature level, and a 20-ton-per-day pilot plant is being constructed by Pechiney Ugine Kuhlmann of France.

The mini-pilot work on nitric acid by the U. S. Bureau of Mines at Boulder City is essentially completed. Nitric acid as a means of extraction of alumina from kaolin has received considerable attention. The first published indication that there could be a technological and economic breakthrough that would permit kaolin to be a competitive ore with bauxite was from projections of production costs using Arthur D. Little's nitric acid process patented in 1971.

A hydrochloric acid extraction of alumina from kaolin method was piloted on a five- to seven-tons-per-day level over an 18-month period by the Anaconda Company. Anaconda used Georgia kaolin for its pilot plant work at Anaconda, Montana. The Anaconda work was proprietary, but reports are that although the method was successful, at the time of piloting (circa 1965) the economics were not competitive with a Bayer-bauxite method.

The U. S. Bureau of Mines is currently doing mini-pilot work on stages of a hydrochloric acid method at Boulder City, Nevada. A fully integrated pilot probably will not be completed until later in 1976. At this time, results are not complete, and good technical data concerning any improvements that have been made during the past 10 years are not available.

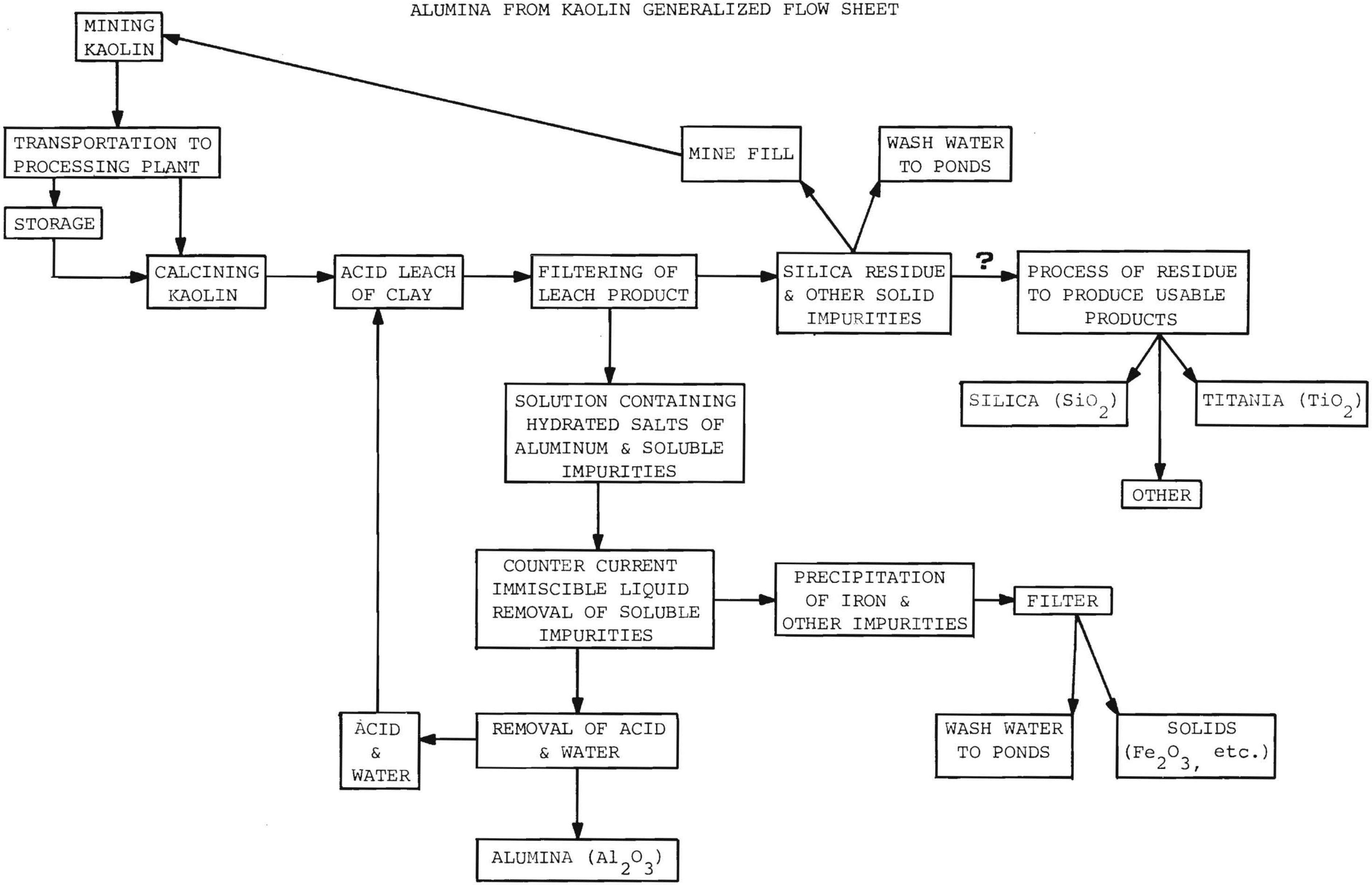
Completion of Pechiney's 20-ton-per-day pilot plant to use the concentrated sulphuric-hydrochloric acid method of production of alumina from kaolin is estimated to be summer of 1976.

Figure 1 is a generalized flow sheet for the production of alumina from kaolin. This figure is correct for the state of the art as currently published. Differences that may be encountered will be in the acid or acids used.

Processes that may be included in Figure 1 consist of closed systems in which the acids and water are recovered and recirculated back into the leach and digestion system. Hence, the greater the efficiency of the systems, the fewer the environmental problems that will be encountered.

Figure 1

ALUMINA FROM KAOLIN GENERALIZED FLOW SHEET



ENVIRONMENTAL PROCEDURES

General

The federal Environmental Protection Agency (EPA) was formed by executive reorganization, with Congressional approval, and became effective December 1970.

Initially, and as specifically enumerated in the original act, there were twenty-six industrial categories for which environmental standards were to be established. This has since been expanded to thirty-seven with the possibility of others in the future. The standards were of two types, each with separate goals and completion dates. The standards have been and are being obtained chiefly through the use of consultants.

The standards to obtain "Best Practical Control Technology Currently Available" have had a target date of July 1, 1977. Some industry categories may have an extension of that date.

The standards to obtain "Best Available Technology Economically Achievable" have had a target date of July 1, 1983.

Among the latest industrial categories is "Ore Mining and Dressing Point Source Category" (Federal Register, Thursday, November 6, 1975, pp. 51722-51733). This contains a subsection on "Bauxite and Other Aluminum Ores" which will establish current approved minimum standards, subject to change at a later date.

The State Executive Reorganization Act of 1972, as amended, created the Georgia Department of Natural Resources and under this Department there was created the Environmental Protection Division.

Georgia is among the states having a major input into the establishment of standards and state government implementation of the federal program of EPA. Effective July 1, 1974, Georgia was authorized to implement the National Pollutant Discharge Elimination System (NPDES) Permit Program. The state is empowered to issue environmental practice permits which also satisfies federal requirements. The Georgia Environmental Protection Division is therefore the single agency for environmental practice in Georgia and processes both applications and permits. The federal EPA has an overview responsibility to assure that the State's air and water quality programs meet all federal requirements.

Currently, a major environmental impact study is not required. Detailed engineering studies are required.

Authorities

The Environmental Protection Division administers and establishes the rules and regulations as required by the appropriate acts concerning environmental protection.

The Environmental Protection Division derives its authority from six laws, namely:

Air Quality Control Act
Solid Waste Management Act
Surface Mining Act
Ground Water Use Act
Water Quality Control Act
Water Supply Quality Control Act

The Surface Mining Act was amended by the 1976 Georgia General Assembly to bring it into agreement with the other five acts. The amended Act becomes effective July 1, 1976, and is quite changed from the Act it replaces.

Contact Personnel

Persons to be contacted within the Environmental Protection Division of the State of Georgia concerning the above acts are:

J. Leonard Ledbetter
Director, Environmental Protection Division
(404) 656-4713

Robert Collom
Chief, Air Protection Branch
Environmental Protection Division
(404) 656-6900

Moses N. McCall, III
Chief, Land Protection Branch
Environmental Protection Division
(404) 656-2833

Gene B. Welsh
Chief, Water Protection Branch
Environmental Protection Division
(404) 656-6593

All of the above are located within the:

Georgia Department of Natural Resources
270 Washington Street, S. W.
Atlanta, Georgia 30334

Procedures

In the discussion to follow, brief statements will be made concerning Georgia's environmental practice, with general statements concerning application to an alumina-from-kaolin industry. The substance of this portion of the report is to inform industry that may be seeking to use kaolin as an ore of aluminum on how to apply for permits and the general procedures to be followed by such companies.

An important aspect of obtaining a permit or license covering environmental practices in Georgia is that only one state office has to be visited to apply, and the application automatically takes care of any permits which may be required by federal or state laws. The State of Georgia is empowered to deal with the Federal Environmental Protection Agency regarding issues pertaining to each company, where it is necessary.

All environmental practice permits in Georgia are obtained from the Environmental Protection Division. This obviously is a convenience to any industry planning to operate in the state. The laws of the state and of the federal government, as they are set up in Georgia, designate the state as the agency to deal with the federal government on environmental matters. This alleviates many time-consuming procedures, as well as the possibility of conflicting interest where multiple offices need to be used for application for permits for environmental practices.

For any company proposing to enter into the production of alumina from kaolin in Georgia, the initial step would be for the appropriate company officials and engineers to schedule an informal discussion with the Director, Environmental Protection Division, Georgia Department of Natural Resources.

The purpose of the meeting will be to determine what policies apply, the information to be provided, and the procedures that the company must follow to be in compliance with Georgia law. At this meeting, the Director will furnish the necessary forms and instruct the company officials as to the standards to be met and the information that will be required for the formal presentation of plans for the project.

A later formal meeting should be scheduled with the Director, Environmental Protection Division, Georgia Department of Natural Resources. The following are to be presented at the formal meeting:

a. A detailed engineering report to include meeting technical standards, as established, a plan of implementation, and appropriate drawings.

b. Completed forms obtained at informal meeting.

c. Overall concepts of dealing with environmental concerns regarding raw materials, effluents, and finished product.

The Director must respond to the formal application for a permit within 60 days.

Discretionary power is given to the Georgia Environmental Protection Division to issue the permit after consideration of information presented at the formal meeting or to request further information or to hold public hearings.

ENVIRONMENTAL CONSIDERATIONS: MINING

Characteristics of Mining

Mining kaolin for the production of alumina will differ in two significant ways from conventional kaolin mining for paper coating or filler purposes. These are the differences in mining rates and end use.

The mining of kaolin for the production of alumina on a fully commercial basis will probably involve a minimum of 3,000 tons per day and a maximum of 12,000 tons per day of kaolin for each alumina plant. This is based on a commercial plant range of capacities of 300,000 tons to 1,000,000 tons of alumina product per year. This rate of mining is much greater than that in conventional mining of kaolin at present.

The other major difference is that kaolin which is mined for filler or paper coating is used as kaolin. In the use of kaolin for the production of alumina, roughly one third of the kaolin is alumina and two thirds is silica. Either most or all of the silica residue will be returned to the mines for mine fill. If all of the silica is returned to the mine for fill, this means that roughly two thirds of the material taken out can be returned in the form of silica. This in turn means that the potentially large holes being left, as may be envisioned by the previously mentioned rate of mining, will not be as large because of the silica fill. Even if some of the silica residue is processed to recover the titania content or some of the silica for purification for use in various applications (either as an abrasive or treated to secure the silicon from the silica), the volume of this should still leave substantial amounts of residue material to be returned to the mines.

The silica residue obtained in the U. S. Bureau of Mines' pilot plant work at Boulder City, Nevada, was coagulated into a product resembling a coarse sand. When silica in this form is returned to a mine fill, it should behave as a coarse sand with the same load-bearing and drainage properties of such a sand. A mix of this material with the overburden being returned to the fill should produce a sandy loam that should be ideal for agricultural purposes. As projected, restored land after the mining of kaolin for alumina could be a better soil for agriculture and recreation than the land that existed before.

Regulation of Land Reclamation

The Georgia Surface Mining Act of 1968, as amended, is directed toward land reclamation related to surface mining and not to control of mining practice. Methods of land reclamation, subject to laws and regulations as abstracted below, are the prerogative of the operator.

REGULATION OF LAND RECLAMATION

LEGAL REFERENCES:	For a detailed legal citation of the information summarized below, see:
	o GEORGIA CODE, CHAPTER 43-14. GEORGIA SURFACE MINING ACT OF 1968, as amended.
	o OFFICIAL COMPILATION RULES AND REGULATIONS OF THE STATE OF GEORGIA, CHAPTER 391-3-3 Amended.
PERMIT:	o A permit must be obtained in order to operate a surface mine.
	o The application for a permit shall be made on a form provided by the Director, Environmental Protection Division. Said permit shall be issued on evidence, satisfactory to the Director, of compliance with the provisions, rules and regulations pursuant thereto. Issuance of a permit will be conditioned upon the permittee's compliance with the approved Mine Land Use Plan.
MINED LAND USE PLAN:	o The Mined Land Use Plan, which must be submitted with the permit application, has to indicate how the operator is going to restore the land to a useful condition acceptable to the Environmental Protection Division.
	o Each operator is given a good deal of discretion in the particular way he wants to restore the land. However, the plan must show that the operator will take measures to protect the health and welfare of the people from the adverse effects of surface mining. Some of the measures are as follows:
	Grade all peaks, ridges, and valleys resulting from surface mining and backfill all pits and trenches resulting from the same.
	No natural creeks, streams, rivers, lakes, or other bodies of water are to be altered in

course or relocated unless authorized in the operator's approved Mined Land Use Plan.

No operator on his own initiative shall construct any protective barrier, dam, berm, silt pond, or similar structure as a part of his surface mining operation without the prior approval of the EPD.

- The Land Use Plan is to include, but is not limited to, a description of:

  Company and minerals or materials to be mined
  Mining methods
  Lands and community to be affected
  Reclamation objective
  Schedule of mining and reclamation, including time to accomplish reclamation
  Affected acreage
  Natural drainage and water disposal
  Provisions for erosion and siltation control
  Protection of contiguous natural resources
  Topsoil use
  Overburden (spoil) and refuse placement or use
  Backfilling
  High wall reduction
  Grading and sloping
  Lake development
  Site clean up
  Revegetation of reclaimed lands
  Location map of affected lands
  Land use map (or accurate aerial photographs)

- Once the structures, equipment, stockpiles, mining refuse, and all other materials associated with surface mining are removed or disposed of, the affected land will be restored to the condition stated in the mining operator's approved Mined Land Use Plan.

- All restored lands must have a neat, clean appearance and contain a high quality, permanent vegetative cover, except those specifically exempted by the Environmental Protection Division.

BONDING REQUIREMENT:

- The Director, Environmental Protection Division, has the authority to exempt a mining operator from the bonding requirement for each Mined Land Use Plan. Exemption from the bonding requirement is obtained by application to the Director and is granted at the Director's discretion.

- Unless a mining operator is specifically exempted from bonding by request to the Director, a bond must be filed within 60 days from the date of being furnished approved surety bond forms by the Division. An amended Mined Land Use Plan, upon approval, is similarly subject to bonding requirements.

- Any bond filed with the Director shall be written by surety approved by the Director and authorized to transact business in the State of Georgia. Bond shall be fixed by the Director in an amount not less than $100 nor more than $1,000 per acre, or fraction thereof, of the area of affected land.

- The bond shall be payable to the Governor and conditioned upon the faithful performance of the statutory rules and regulations pertaining thereto.

- Mining operators shall have the option of posting bond, government securities, cash, or any combination thereof, on each mined area. The surety shall be held by the Division until the affected land is satisfactorily reclaimed in the opinion of the Director, at which time surety will be terminated by cancelling bond and/or return of any government securities or cash.

- If the mined area is not satisfactorily reclaimed, the Director may expend as he deems appropriate such portion of the bond as is necessary to complete the mining operator's responsibilities under the Mined Land Use Plan.

Control of Erosion and Sedimentation

In addition to the surface mining regulations, regulations relating to erosion and sedimentation will also apply in a surface mining area and also where noncovered bulk storage of kaolin is used at plant sites or other areas.

The following abstract pertaining to the control of erosion and sedimentation is quoted from "Environmental Regulations for Georgia Industry."

CONTROL OF EROSION AND SEDIMENTATION

The EROSION AND SEDIMENTATION ACT OF 1975 (GEORGIA CODE, CHAPTER 5-23A) allows counties and municipalities to regulate soil erosion and sediment deposition onto lands and into water of the State. The State already has this authority under its Water Quality laws and is attempting to share this responsibility with local governments.

The *Act* has given the governing authority of each county and municipality until April 24, 1977 to adopt a comprehensive ordinance which sets up procedures that regulate land-disturbing activities.

These activities are defined as those which may cause soil erosion from water or wind and the movement of sediments into water or onto lands of the State. They include but are not limited to clearing, dredging, grading, excavating, and the transporting and filling of lands other than federal lands.

This comprehensive ordinance must at least contain these requirements:

- o Stripping of vegetation, regrading and other development activities shall be conducted in such a manner so as to minimize erosion.
- o Cut-fill operations must be kept to a minimum.
- o Development plans must conform to topography and soil type so as to create the lowest practical erosion potential.
- o Whenever feasible, natural vegetation shall be retained, protected and supplemented.
- o The disturbed areas and the duration of exposure to erosive elements shall be kept to a practicable minimum.
- o Disturbed soil shall be stabilized as quickly as practicable.
- o Temporary vegetation or mulching shall be employed to protect exposed critical areas during development.
- o Permanent vegetation and structural erosion control measures must be installed as soon as practicable.
- o To the extent necessary, sediment in run-off water must be trapped by the use of debris basins, sediment basins, silt traps, or similar measures until the disturbed area is stabilized.
- o Adequate provisions must be provided to minimize damage from surface water to the cut face of excavations or the sloping surfaces of fills.
- o Cuts and fills may not endanger adjoining property.
- o Fills may not encroach upon natural water courses or constructed channels in a manner so as to adversely affect other property owners.
- o Grading equipment must cross flowing streams by the means of bridges or culverts except when such methods are not feasible and provided, in any case, that such crossings are kept to a minimum.

Land-disturbing activities governed by comprehensive ordinances do not include:

- o Surface mining (as defined in the GEORGIA SURFACE MINING ACT OF 1968), (GEORGIA CODE, CHAPTER 43-14).
- o Granite quarrying and land clearing for such quarrying.
- o Minor land-disturbing activities such as home gardens, individual home landscaping and other related activities which result in minor soil erosion.
- o Construction of single-family residences when such are constructed by or under contract with the owner for his own occupancy.
- o Agricultural practices which involve such activities as harvesting, planting of pasture land, livestock and poultry management practices.
- o Any project carried out under the technical supervision of the Soil Conservation Service of the U. S. Department of Agriculture.
- o Activities which involve a land change of five acres or less or the movement of not more than 500 cubic yards of land. This exemption does not apply to any land-disturbing activity within 200 feet of the bank of any major stream or river which drains at least a land area of 100 square miles.
- o Construction or maintenance projects undertaken or financed in whole or in part by:

  Georgia Department of Transportation
  Georgia Highway Authority
  Georgia Tollway Authority
  Any county or municipality

- o Activity for which bids have been let or a construction contract signed prior to effective date of local ordinance or local government board regulation, provided that the activity is completed within 12 months of such effective date.

If the county or municipality does not enact this comprehensive ordinance by April 24, 1977, the Department of Natural Resources, in cooperation with the State Soil and Water Conservation Committee, will adopt rules and regulations which control land-disturbing activities. The rules and regulations will contain the same requirements that must be in the comprehensive ordinance.

By April 24, 1977, any industry that engages in land-disturbing activities will have to obtain a permit from either the county or municipality (if an approved ordinance is in effect), or from the

Environmental Protection Division of the Department of Natural Resources. The industry applying for a permit must submit erosion and sediment control plans and supportive data which indicate that the land-disturbing activity will be carried out so as to meet the minimum requirements contained in the ordinance or rules and regulations. The permit will be issued only when the applicant's plan has been reviewed by the Soil and Water Conservation District and does in fact show that these requirements can be met. Specific conditions may be imposed with a permit.

Until April 24, 1977, enforcement of the minimum requirements for the prevention of soil erosion and sedimentation will be by counties and municipalities. After this date, the Department of Natural Resources will have enforcement procedures for its own rules and regulations but only for those counties and municipalities which do not have ordinances in effect.

ENVIRONMENTAL CONSIDERATIONS: PROCESSING

Input into and discharge from the alumina-from-kaolin process may require environmental safeguards. Such inputs and discharges are discussed in this section with applicable abstracts of Georgia law and regulations.

Water Supply

Water consumption of the alumina-from-kaolin process has been variously estimated at between 5,000,000 and 21,000,000 gallons per day. The variance results from different operating capacities and different acids that may be used in the processing. The minimum water requirement is estimated to be on an order of 5,000,000 gallons per day for a 300,000 tons per year output of alumina product. The larger figure represents a maximum capacity plant of up to 1,000,000 tons per year of alumina. Unknown at this point is the efficiency of the water collection and acid collection system which will recirculate the recovered water in the processing. There also will be recirculation of water from storage ponds where wash water will be discharged. Hence, the actual daily requirement of new water is not known.

Below is an abstract of the regulation of the use of ground water.

REGULATION OF GROUND WATER USE

LEGAL REFERENCES: For a detailed legal citation of the information summarized below, see:

- GEORGIA CODE, CHAPTER 17-11. GROUND WATER USE ACT OF 1972, as amended.
- OFFICIAL COMPILATION RULES AND REGULATIONS OF THE STATE OF GEORGIA, CHAPTER 391-3-2.

PERMIT:

- Any industry, unless exempted by law, must obtain permit to withdraw, obtain, or utilize ground water in excess of 100,000 gallons per day for any purpose.
- Permit requirements differ according to whether the ground water will be put to either a consumptive or nonconsumptive use.
- During the early planning stages for a proposed ground water withdrawal, and in any case prior to the start of well construction, the intended

user should request a conference with the Environmental Protection Division (EPD).

- Representatives of the EPD will determine the acceptability of proposed wells, the aquifers to be utilized, the well spacing and well depth, and the amount and intended ground water use.

- After considering all the factors, the EPD may issue a letter of concurrence setting forth such terms and conditions as it considers necessary.

- Such a letter is not mandatory, but the user proceeds at his own risk if he fails to obtain it.

- After completing construction of the well or wells, but before water use begins, the intended user must apply for a ground water use permit on forms furnished by the Division.

- The application for a permit should at least include:

  Owner identification data
  Aquifer(s) utilized
  Amount and purpose of ground water use
  Detailed well construction data including drillers' logs
  Well location(s) (latitude and longitude and location map)

- The Environmental Protection Division will consider the following factors when it decides whether the permit should be granted:

  Number of persons using an aquifer and the object, extent and necessity of their respective withdrawals or uses.

  Nature and size of the aquifer.

  Physical and chemical nature of any impairment of the aquifer.

  Probable severity and duration of such impairment under foreseeable conditions.

  Injury to public health, safety or welfare which results if such impairment were not prevented or abated.

  Businesses or activities to which the various uses are related.

Importance and necessity of the uses claimed by permit applicants.

Extent of any injury caused to other water uses (including public use).

Diversion from or reduction of flows in other water courses or aquifers.

Any other relevant factors, such as, but not limited to, the best geologic and hydrologic information available of the aquifer or ground water system of the area.

- Duration of Permit: Permits are normally issued for ten years, but a longer period may be authorized by the EPD to provide for reasonable amortization of the applicant's water withdrawal and water using facilities.

CONSUMPTIVE-USE PERMIT: Some of the conditions that may be imposed along with the granting of a consumptive-use permit include:

Total permitted well depth in feet.

Aquifer(s) or ground water system to be utilized.

Maximum pumping rate.

Pumping level (elevations below which water may not be pumped).

Amount of ground water to be withdrawn or used.

Well spacing to minimize well interference.

Time of withdrawal.

Require observations or monitoring well(s) be installed for monitoring ground water levels and water quality.

NONCONSUMPTIVE-USE PERMIT:

- None of the above conditions may be imposed on the user once a nonconsumptive-use permit is granted.

- Nonconsumptive use means the use of water withdrawn from the ground water system or aquifer in such a manner that it is returned to the ground water system or aquifer from which it was withdrawn without substantial diminution in quantity or substantial impairment in quality at or near the point from which it was withdrawn.

- In determining whether a use of ground water is nonconsumptive the Environmental Protection Division considers (based on the best geologic and hydrologic information available) whether any material injury to other water users of the area by reason of the reductions of water pressure in the aquifer or system has not been adequately compensated by the permit applicant who caused or substantially contributed to this injury.

- Granting of a nonconsumptive-use permit does not imply consent to inject any waste or pollutant material into the ground water system.

GROUND WATER USE REPORT:

- Once a permit is granted, the user must file semiannually with the Environmental Protection Division a certified statement (ground water use report) on forms furnished by the Division which states:

  Quantities of water withdrawn and/or injected
  Sources of water
  Nature of the use
  Static and pumping water level in selected wells

- A specific conductance analysis of raw water is required annually.

DEWATERING WELLS:

- A permit will not be required for the withdrawal of ground water in excess of 100,000 gallons per day if:

  It involves dewatering the subsurface rock to a depth of not more than 30 feet, or to a greater depth if approved by the EPD, and

  Is for the purpose of construction of trenches for sewer or water pipes, or excavation for foundations, or utility construction, and

  Is for a period of not more than 60 days, unless an extension of time is approved by the EPD.

SALT WATER ENCROACHMENT OR DETERIORATION OF WATER:

To protect against salt water encroachment or the deterioration of the water quality of the ground water, the Environmental Protection Division may require various control measures, a list of which can be found in the RULES AND REGULATIONS.

INSPECTIONS AND INVESTIGATIONS:	EPD has the power to enter at reasonable times any private or public property for the purpose of inspecting or investigating conditions relating to the use of ground water.
OTHER LAWS:	Industries should be aware that there might be municipal or county ordinances which relate to the regulation of ground water use.

Air Emissions

A potential area in the alumina-from-kaolin process in which air quality control regulations would apply is in the calcination of the clay, where proper precaution will need to be observed to meet the specific emission standards. In the water-chemical treatment of the kaolin from leaching to the final recovery of the alumina product, care must be exercised so that there is no escape of acid vapors or excess steam in the process. The process will be designed as a closed system in order to recover both the water and the acid. The economics of the process require as complete a recovery of the acid as possible in order that the process may be competitive with the Bayer-bauxite process. From the standpoint of air quality control, this means that it will be a matter of design and maintenance to prevent any unplanned air emissions.

An abstract of air quality control regulations is set forth below.

AIR QUALITY CONTROL

LEGAL REFERENCES: For a detailed legal citation of the information summarized below, see:

- GEORGIA CODE, CHAPTER 88-9. AIR QUALITY CONTROL ACT, as amended.
- OFFICIAL COMPILATION RULES AND REGULATIONS OF THE STATE OF GEORGIA, CHAPTER 391-3-1 Amended.

PERMITS: Granting of a permit depends on the industry's demonstrable capability to meet specific standards found in the RULES AND REGULATIONS.

- *Construction Permit:* A permit is required prior to construction or modification of any facility which may result in air pollution.
- *Temporary Operating Permit:* Contains a compliance schedule specifying steps to be followed to achieve final compliance with the *Act*, rules and regulations.

- *Operating Permit:* Permit application is required within 30 days after commencement of operations. Permit is issued if final compliance with the *Act*, rules and regulations is achieved.

- The permit will specify the conditions under which the facility must be operated so as to comply with the *Act*, rules and regulations.

- Consulting the Air Protection Branch, prior to permit application, is recommended.

EMISSION STANDARDS: Specific emission standards exist for:

Smoke
Incinerators
Fuel-burning equipment
Particulate emission from manufacturing processes
Fluoride
Sulfur Dioxide
Nitric acid plants
Sulfuric acid plants
Nitrogen oxides
Conical burners
Fugitive dust
Cupola furnaces for metallurgical melting
Particulate emissions from kaolin and fuller earth processes
Particulate emissions from cotton gins

- Monitoring: Monitoring and reporting of emissions by industry may be required by EPD if conditions warrant.

AMBIENT AIR STANDARDS: Industries must also meet air standards relating to the concentration of pollutants in the air immediately surrounding the plant. Concentration standards exist for:

Sulfur dioxide
Particulate matter
Carbon monoxide
Total oxidants
Non-Methane hydrocarbons
Nitrogen dioxide

OPEN BURNING:

- Prohibited. Exceptions allowed by State.

FEDERAL STANDARDS: The Federal Environmental Protection Agency's (EPA) air standards are met when the industry complies with Georgia's air standards. It is suggested that consultation with the State agency occur if there are specific questions.

INSPECTIONS AND INVESTIGATIONS:	EPD has the power to enter at reasonable times any private or public property for the purpose of inspecting and investigating conditions relating to air pollution and obtaining samples of emissions.

Liquid Discharge

Liquid discharge will take place in the washing of the silica residue from the leaching process and from the washing that will take place in the removal of the impurities in the immiscible liquid series. Wash water from both of these areas will probably be discharged into a pond and the water eventually recirculated. It should be emphasized that no acid discharge is envisioned, since it is essential that the acid be recovered as fully as possible in the closed system. There could be some acid in the wash water from both the silica residue and the impurity separation. This will probably need to be neutralized before entering into the pond system.

Surface water runoff entering streams is controlled by federal and state law. In addition to water quality control regulations, the regulations concerning sedimentation quoted under the section on mining also apply.

An abstract of water quality control regulations is set forth below.

WATER QUALITY CONTROL

LEGAL REFERENCES: For a detailed legal citation of the information summarized below, see:

- o GEORGIA CODE, CHAPTER 17-5. GEORGIA WATER QUALITY CONTROL ACT, as amended.
- o OFFICIAL COMPILATIONS RULES AND REGULATIONS OF THE STATE OF GEORGIA, CHAPTER 391-3-6.

PERMIT:

- o The granting of a discharge permit depends on the industry's demonstrable capability to meet specific standards found in the RULES AND REGULATIONS.
- o A discharge permit is required to operate any system for the disposal of sewage, industrial wastes, or other wastes into the water.
- o The application for such discharge permit should include:

    Complete engineering reports
    Schedule of progress
    Plans

Specifications
Maps
Measurements
Quantitative and qualitative determinations
Records
All other information as the Environmental Protection Division may require

- Georgia is authorized to issue the *NPDES* permit.

APPROVAL FOR CONSTRUCTION:

- Any industry that desires to erect, modify, or alter a sewerage system must obtain approval of any plans, specifications and related materials for such system prior to commencement of construction.

- Engineering reports which are submitted must be prepared by a professional engineer competent in the treatment of water pollutants and must contain:

  Information regarding the existing sewerage system, if applicable.

  Characteristics of existing pollutants and existing or proposed treatment of such pollutants.

  Demonstration of the need for the proposed sewerage system.

  Evaluation of alternatives to define the most cost effective method for meeting established effluent limitations, water quality goals.

  Results to be expected from treatment process.

  Sufficient maps, charts, tables, calculations, basis of design data and graphs to make the report readily understandable.

  An operation and maintenance program description.

  Such other pertinent engineering information as the Environmental Protection Division (EPD) may require.

- Plans and specifications submitted to the EPD for a sewerage system shall include the following:

  Map showing area to be served by the sewerage system.

  Profiles of proposed sewers.

Construction details of manholes and other special sewer structures.

General and detail plans for the treatment facility.

Complete design data for the treatment facility plans, to be submitted in duplicate on forms specified by the Division.

Specifications for the construction of the sewerage system.

Such other plans and specifications as the Division may require.

- General map plans submitted to the EPD for a sewerage system shall include the following:

  Map plan that shows the entire area to be served.

  All existing and proposed streets in the area to be served; surface elevators at all street intersections, etc.

  Clear designation on the plan by suitable symbols of all sewer appurtenances, including but not limited to, manholes, siphons and pumps.

  Such other information as the EPD may require.

- Sewer plans and profiles submitted to EPD for a sewerage system shall include the following:

  Sewers and force mains, drawn at a scale that shows the profile for all manholes, siphons, railroad crossings, street or stream crossings, elevations of stream beds, normal stream water levels, and sizes and grades of sewers which show surface elevations and sewer invert elevations.

  Detailed drawings of all sewer appurtenances, including but not limited to, manholes, inspection chambers, siphons, lift stations, and any special structures to accompany the sewer plans. Detail drawings shall be to a scale suitable to clearly show the design details.

- Plans for treatment facilities submitted to the EPD shall include the following:

General plan that clearly identifies the exact location of the facilities, areas reserved for future expansion, access roads to various units, etc.

Detail plans which show longitudinal and traverse sections sufficient to explain the construction of each treatment unit.

Flow measuring devices at appropriate points in the plan. Sampling and recording devices may be required by the EPD when deemed necessary.

Such other information as EPD may require.

CONSULTATION:

- It is highly recommended that the industry applying for a discharge permit or seeking approval for the proposed erection, modification or alteration of a sewerage system consult with the Environmental Protection Division in order to work out a system which will enable him to comply with the specific environmental standards. In any event, the EPD may request a conference with the industry before it submits any application for a permit, or a proposal for construction.

- The EPD has the obligation to supply the industry with technical and scientific information as may be helpful in reducing or eliminating the polluting effects of the discharge. Yet the responsibility for development and application of means of preventing pollution rests with the company causing the pollution.

GENERAL CRITERIA FOR ALL WATERS:

- All waters shall be free from:

  Materials which will settle to form sludge deposits that become putrescent, unsightly or otherwise objectionable.

  Oil, scum and floating debris in amounts sufficient to be unsightly or to interfere with legitimate uses.

  Material which produces turbidity, color, odor or other objectionable conditions which interfere with legitimate water uses.

  Toxic, corrosive, acidic and caustic substances discharged in amounts, concentrations or combinations which are harmful to humans, animals or aquatic life.

- Applicable State and Federal requirements and regulations for the discharge of radioactive substances shall be met at all times.

- No man-made physical or other alteration of stream beds that may violate established water quality standards, or reduce the waste assimilative capacity of the streams, will be permitted without the expressed approval of the Environmental Protection Division.

WATER USE CLASSIFICATIONS:

- The Environmental Protection Division has established water use classifications as follows:

  Drinking water supplies
  Fishing, propagation of fish, shellfish, game and other aquatic life
  Recreation
  Agricultural
  Industrial
  Navigation
  Wild river
  Scenic river
  Urban stream

- There are different standards applicable to each specific water usage which deal with the following areas of regulation:

  Amount of bacteria that may be discharged into the water

  Dissolved oxygen level of the water

  pH range of the water

  Temperature level of the water

  Presence of toxic waste and other deleterious materials

  Presence of floating solids, settleable solids, sludge deposits or any taste, odor, or color producing substances

  Presence of sewage, industrial or other wastes

  Any other areas that are specifically dealt with in the RULES AND REGULATIONS

INSPECTIONS AND INVESTIGATIONS:

The Environmental Protection Division (EPD) has the power to enter at reasonable times any private or public property for the purpose of inspecting and investigating conditions relating to water pollution.

MONITORING, RECORDING AND REPORTING REQUIREMENTS:	Where a person discharges pollutants into the water authorized by the permit, EPD may require the person to: Establish and maintain records Make reports Install, use and maintain monitoring equipment of methods including, where appropriate, biological monitoring methods Sample such discharge, in accordance with such methods, at such localities, at such intervals, and in such manner as the EPD shall prescribe Provide such other information as the EPD may reasonably require
LOCAL WATER QUALITY CONTROL:	The corporate authorities of the cities and towns in Georgia have the power to prohibit the throwing or depositing of any substance in navigable waterways within their jurisdictions which they consider dangerous to navigation or injurious to vessels or to property along such navigable waters. (See GEORGIA CODE, CHAPTER 80-1).

Solid Waste

Solid waste in the alumina-from-kaolin process will consist of the residue from the leaching process and precipitated material taken out of the immiscible liquid series in the removal of impurities. As previously stated, it is envisioned that most -- if not all -- of the solid waste from the leaching will be returned to the mine area as fill.

However, since some solid waste management will be involved, an abstract of the appropriate regulations is quoted below.

SOLID WASTE MANAGEMENT

LEGAL REFERENCES:	For a detailed legal citation of the information summarized below, see: o GEORGIA CODE, CHAPTER 43-16. SOLID WASTE MANAGEMENT ACT. o OFFICIAL COMPILATION RULES AND REGULATIONS OF THE STATE OF GEORGIA, CHAPTER 391-3-4 Amended.

PERMIT: It should be emphasized that the granting of a permit depends on the industry's demonstrable capability to meet specific standards found in the RULES AND REGULATIONS. A permit is required for these solid waste activities:

Storage
Collection
Transportation
Utilization
Processing
Disposal
Disposal facility construction
Disposal facility operation

PROHIBITED ACTS:

- Handling of solid waste which:

  Creates a nuisance
  Contributes to insect and rodent infestation
  Contributes to the harboring or feeding of animals
  Impairs the quality of the environment
  Creates other hazards to the public health

- Burning of solid waste, except by an approved method.

- Permitting scavenging at a disposal site.

- Open dumping.

- Hazardous wastes and sludges not handled in accordance with a written, approved procedure.

- Disposal of special wastes without an approved proposal.

- Site closures without prior 30-day written notice and approved closing procedures.

- Failure to maintain closed sites for a period of one year, with special attention to erosion control and development of adequate vegetative cover.

EXEMPTIONS:

- Disposing of solid wastes originating from an individual's own residence onto land or facilities owned by him, when disposal of such does not thereby adversely affect public health.

- Disposing of livestock feeding facility waste from facilities with a total capacity of up to 1,000 cattle or 5,000 swine.

- Livestock feeding facility regardless of total per head capacity, if an approved waste disposal system is provided that can properly dispose of runoff from a "ten year storm."

- Use of poultry or other animal manure for fertilizer.

GUIDELINES: GUIDELINES that can assist industries in complying with the RULES AND REGULATIONS are available from the Solid Waste Management Section. Five GUIDELINES are available:

Sanitary landfill or landfill disposal of liquid, semi-solid, and industrial sludge wastes.
Hazardous solid wastes.
Control of flies and odors on caged layer poultry farms.
Highly putrescible solid wastes.
Sanitary landfill disposal of solid latex wastes.

COLLECTION AND TRANSPORTATION:

- Owners or occupants are responsible for the collection and transportation of solid waste accumulated on their property, unless the services of a licensed collector have been engaged.

- Vehicles transporting putrescible waste must be covered, substantially leakproof, durable, and of easily cleanable construction.

- Vehicles must be cleaned frequently and maintained in good repair.

- Vehicles must be loaded, covered, and moved in such manner as to prevent littering and spillage.

- Special precautions must be taken regarding these areas of transfer station maintenance:

  Scattering
  Accumulation
  Floor maintenance
  Sewage solids
  Hazardous wastes
  Dust
  Pests

DISPOSAL:

- Sanitary Landfill Operations. Special precautions must be taken regarding:

  Unloading
  Spreading and compaction
  Daily cover

Intermediate cover
Final cover
Grading and drainage
Continuity of operation
Environmental protection
Hazardous waste
Supervision
Limited access
Litter control
Fire protection

- o Landfill Operations. Special precautions must be taken regarding:

  Spreading and compaction
  Cover
  Grading and drainage
  Environmental protection
  Limited access
  Fire protection

- o Other Disposal Operations. Special approval must be obtained.

PROCESSING:

- o Incineration or pyrolysis. Special precautions must be taken regarding:

  Supervision
  Residue
  Waste water
  Air quality
  Posted information
  Cleanliness and sanitation
  Fire control

- o Shredding. Special precautions must be taken regarding:

  Supervision
  Shredding
  Waste water
  Air quality
  Posted information
  Cleanliness and sanitation
  Fire control

- o Baling. Special precautions must be taken regarding:

  Supervision
  Bale size
  Waste water
  Air quality

Posted information
Cleanliness and sanitation
Fire control

- o Reclamation and Recycling. Special precautions must be taken regarding:

  Supervision
  Storage
  Incineration
  Posted information
  Fire control

- o Composting. Special precautions must be taken regarding:

  Supervision
  Posted information
  Residue
  Cleanliness and sanitation
  Fire control

- o Other Processing Operations. Prohibited unless special approval obtained.

INSPECTIONS AND INVESTIGATIONS:	o EPD has the power to enter at reasonable times any private or public property for the purpose of inspecting or investigating conditions relating to air pollution.
OTHER LAWS:	The *Act* in no way limits the power of various public bodies, officials and private citizens to impose additional nonconflicting regulations on solid waste disposal in their own jurisdictions.
TRANSPORTATION OF GARBAGE ACROSS STATE & CERTAIN COUNTY BOUNDARIES:	Prohibited, except with permission of authorities in county where garbage will be dumped (See GEORGIA CODE, CHAPTER 23-32, as amended).

<u>Potable Water</u>

There will be a need for a source of potable water for the employees of an alumina-from-kaolin plant. In the event that such a plant is located in an area that cannot be serviced by a public or community water supply system, the company will have to provide its own water supply system.

An abstract of water supply quality control regulation is set forth below.

WATER SUPPLY QUALITY CONTROL

LEGAL REFERENCES: For a detailed legal citation of the information summarized below, see:

- GEORGIA CODE, CHAPTER 88-26. GEORGIA WATER SUPPLY QUALITY CONTROL ACT, as amended.
- OFFICIAL COMPILATION RULES AND REGULATIONS OF THE STATE OF GEORGIA, CHAPTER 391-3-5.

CERTIFICATE OF APPROVAL:

- A *Certificate of Approval* is required to operate a public or community water supply system.
- The granting of the *Certificate of Approval* is based on whether the particular water supply system meets specified requirements and has the capability of providing a sufficient quantity of water meeting standards governing the quality of such water set forth in the RULES AND REGULATIONS.
- Once granted, the Certificate will indicate the operating conditions that must be followed.

CONSTRUCTION OF THE WATER SUPPLY SYSTEM: Before an industry is permitted to construct its water supply system, it must submit to and have approved by the Environmental Protection Division:

Engineering report prepared by a professional engineer containing a comprehensive description of the feasibility of the proposed project. A list of certain items that must be included in the report can be found in the RULES AND REGULATIONS.

Plans and Specifications prepared by a professional engineer that should include, but are not limited to, areas to be served by the water system, source and the treatment facilities of the system, and plant laboratory equipment necessary to make all analyses for the control of the processes involved.

General Plan Map that indicates the location of various structures, the size and type of the materials of the existing and proposed water mains, and other items enumerated in the RULES AND REGULATIONS.

WATER SUPPLY CLASSIFICATIONS: In some instances varying requirements are set forth in the RULES AND REGULATIONS applying to these three classes:

Class I.	Water supply systems supplying finished water from any surface water sources.
Class II.	Water supply systems supplying finished water from ground water sources to more than 25 housing or mobile units, to schools, to State owned facilities, and to industrial operations employing more than 100 persons.
Class III.	All other water supply systems supplying finished water from ground water sources, including but not limited to, tourist accommodations, food service establishments, and commercial establishments.

SOURCE OF WATER SUPPLY:

- Industries must collect raw water samples for bacteriological examination before approval can be obtained for a source of water supply.
- Standards for surface and ground water sources are found in the RULES AND REGULATIONS.

WATER TREATMENT FACILITIES:

Specific standards exist for:

Design and operation of surface and ground water treatment plants

Raw water and multi-level intakes

Raw water lines

Chemical feed equipment

Initial mixing

Flocculation

Sedimentation

Filtration

Use of finished water

Chlorination

Fluoridation

WELLS:

Specific standards exist for:

Distance between a well and a septic tank

Protection of pumping equipment and water treatment facilities

Construction of the well and maintenance of construction data

Turbine and submersible pump installation

Well casing

Location of the raw water sampling tap and the blow-off pipe

Rehabilitation of existing wells

Plugging and sealing of drilled holes

Furnishing of samples of raw water for bacteriological examination

Furnishing of the results of physical and chemical analysis of the raw water

SPRINGS: Specific standards exist for:

Construction and operation of springs

Furnishing of samples of the raw water for bacteriological examination

Furnishing the results of physical and chemical analysis on the untreated water

STORAGE TANKS AND DISTRIBUTION SYSTEM: Specific standards exist for their construction and operation

DISINFECTION: Specific disinfection standards exist for:

All newly constructed water supply systems

Storage tanks

Water mains

Wells

OPERATION OF THE WATER SUPPLY SYSTEM: Specific standards exist for:

Chlorination of the system

Experienced operator on duty

Maintenance of a chemical and biological laboratory

Performance of bacteriological and chemical tests

Collection of samples for bacteriological tests

WATER SAMPLES:	Specific standards exist for: Number and places where samples must be taken Shipment of samples
OPERATING RECORDS:	Specific standards exist for the maintenance of operating records.
DRINKING WATER STANDARDS:	Specific standards exist for: Bacteriological quality Physical characteristics Chemical characteristics Presence of radioactive materials
INSPECTIONS AND INVESTIGATIONS:	EPD has the power to enter at reasonable times any private or public property for the purpose of inspecting or investigating conditions relating to the furnishing of water to the public.

ENFORCEMENT OF LAWS AND REGULATIONS

Enforcement actions are directed toward non-compliance with the applicable laws and regulations and pertain essentially to operating companies. An alumina-from-kaolin industry would be a new industry with new technologies and as such could not obtain permits without compliance.

Of the six types of environmental controls where enforcement is specified, all actions are similar in kind and severity with the exception of Water Quality Control. The five which are similar specify four types of action which may be taken by EPD.

Those actions are abstracted below.

ADMINISTRATIVE ORDER:

- When there is reason to believe that there has been a violation, the Environmental Protection Division (EPD) will first try to settle the controversy by conference, conciliation, and persuasion. If this fails, EPD has the authority to issue an administrative order, stating the necessary corrective action to be taken.
- A hearing before EPD's Administrative Review Officer may be requested no later than 30 days after such order is issued.

INJUNCTION: When there is reason to believe that any company has violated or is about to violate any provision of the *Act*, EPD may apply for an injunction to enjoin such violation.

MISDEMEANOR: Any industry that violates any provision of the *Act* or any rule or regulation, or fails, neglects or refuses to comply with any final administrative order will be found guilty of a misdemeanor and be punished by a fine not to exceed $1,000 or by imprisonment for no more than one year, or both.

CIVIL PENALTY: Any industry that violates any provision of the *Act*, or negligently or intentionally fails or refuses to comply with a final administrative order is liable to a civil penalty not to exceed $1,000 for such violation and an additional civil penalty not to exceed $500 for each day during which said violation continues.

The Water Quality Control enforcement has more severe fines than above and also includes a provision for Civil Liability.

Enforcement regulations are contained in the appropriate Georgia Codes as listed below.

Environmental Control	Georgia Code Chapter
Land Reclamation	43-4
Ground Water Control	17-11
Air Quality Control	88-9
Water Quality Control	17-5
Solid Waste Control	43-16
Potable Water	88-26

Chapter 5

WATER REQUIREMENTS AND AVAILABILITY

Requirements

Approximately 7,000,000 gallons per day make-up water are estimated to be required for a 1,000-ton-per-day Al_2O_3 plant using kaolin.

Availability

Surface water measurements taken during the 1957 drought were as follows: Brier Creek at Highway 88 at Keysville, Georgia, was 34 cubic feet per second or 915,586 gallons per hour, and the Oconee River near Oconee was 90 cubic feet per second or 2,423,600 gallons per hour. The Ogeechee River near Louisville flowed 5.5 cubic feet per second or 148,000 gallons per hour. Obviously, the Savannah River is adequate. A kaolin company located south of Macon pumps roughly 25 million gallons of water daily from one of its mines just to dispose of it.

On a line roughly parallel to the Fall Line and approximately 30 miles away from it to the south, groundwater of sufficient quantity at depths of from 600 to 800 feet should be available from wells. Recovery from such wells is on an order of magnitude of 1,000 gallons per minute or 1,440,000 gallons per 24-hour day. Thus, five wells could supply the raw water requirements of 7,000 gallons per ton of Al_2O_3 for a 1,000-ton-per-day Al_2O_3 plant. Louisville in Jefferson County, Georgia, is an example of a location that is the appropriate distance away from the Fall Line to get sufficient water using wells as previously mentioned. This information was obtained from the Georgia District Office of the U. S. Geological Survey, Hydrology Division.

Chapter 6

TRANSPORTATION AVAILABILITY

Major transportation requirements for an alumina-from-kaolin industry are for rail and water movement of large tonnages of material both incoming and outgoing. Wherever a plant is located in Georgia adequate transportation is readily available.

Rail

Georgia is served by two major rail systems. The Southern Railway System, which has 11 other railroads in the system, and the Seaboard Coast Line Railroad Company, which has four other railroads in the system, blanket the state. In addition, there are six independent short-line railroads operating within the state. These railroad systems provide excellent rail service within the state and to any point outside the state over their own lines or connecting lines. Map 2 shows the railroads serving Georgia.

Water

Georgia has two deepwater ports at Brunswick and Savannah and three inland ports at Augusta, Bainbridge, and Columbus. These five ports are connected to the inland waterway system of the eastern United States. Georgia's port system can utilize over 29,000 miles of sheltered inland water routes. Map 3 shows Georgia's inland waterway connections.

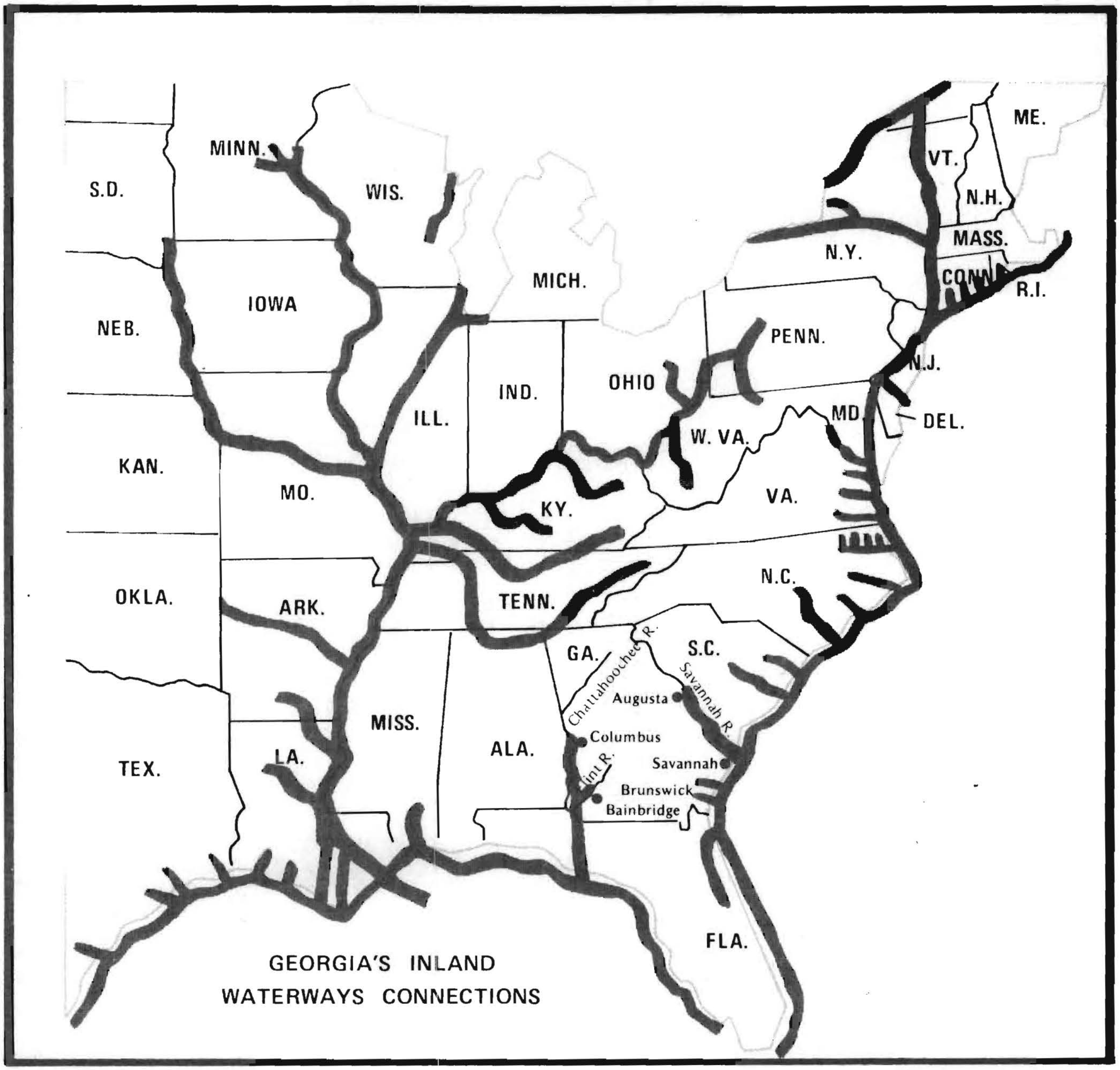
Other Transportation Information

A 33-page illustrated booklet, "Georgia Transportation Systems," with text, charts, graphs, and maps depicting Georgia transportation systems, is available from the Georgia Department of Community Development. This booklet contains detailed information on air, rail, truck, and water transport.

Map 2


RAILROADS SERVING GEORGIA
LEGEND
AGS - ALABAMA GREAT SOUTHERN
A & N - ALBANY & NORTHERN
ASM & L - ATLANTA STONE MOUNTAIN & LITHON
A & WP - ATLANTA & WEST POINT
C of G - CENTRAL OF GEORGIA
CI - CHATTAHOOCHEE INDUSTRIAL
GM - GAINESVILLE MIDLAND
GA - GEORGIA
GAS & C - GEORGIA ASHBURN SYLVESTER & CAMILLA
G & F - GEORGIA & FLORIDA
GN - GEORGIA NORTHERN
GS & F - GEORGIA SOUTHERN & FLORIDA
HW - HARTWELL
L & N - LOUISVILLE & NASHVILLE
L & W - LOUISVILLE & WADLEY
M - MILSTEAD
SM - ST MARYS
S - SANDERSVILLE
S & A - SAVANNAH & ATLANTA
SCL - SEABOARD COAST LINE
SOU - SOUTHERN
SG - SOUTH GEORGIA
TA & G - TENNESSEE ALABAMA & GEORGIA
VS - VALDOSTA SOUTHERN
W & T - WRIGHTSVILLE & TENNILLE
TENNESSEE
NORTH CAROLINA
SOUTH CAROLINA
ALABAMA
FLORIDA
ATLANTIC OCEAN
ATLANTA
MACON
COLUMBUS
AUGUSTA
SAVANNAH
ALBANY
VALDOSTA
ATHENS
ROME
MARIETTA

Map 3


MINN.
S.D.
WIS.
IOWA
NEB.
MICH.
ILL.
IND.
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KAN.
MO.
KY.
OKLA.
ARK.
TENN.
N.C.
S.C.
GA.
TEX.
LA.
MISS.
ALA.
FLA.
Chattahoochee R.
Savannah R.
Flint R.
Augusta
Columbus
Savannah
Brunswick
Bainbridge
GEORGIA'S INLAND
WATERWAYS CONNECTIONS

Chapter 7

ENVIRONMENTAL CONSIDERATIONS

This section discusses the environmental regulations which would pertain to the establishment of a kaolin-to-alumina plant in Georgia.

Air Quality Control

In general, the standards for air quality are the most extensive of all environmental-related regulations and are maintained by the Board of Health of the State of Georgia through the Director of the Division of Environmental Protection of the Department of Natural Resources. Anyone causing emissions to be released into the atmosphere and resulting in air pollution may be required to install and maintain emission control devices. Further, anyone planning the construction or modification of any facility that might cause air pollution must obtain a permit from the Department of Natural Resources by presenting evidence that all rules and regulations will be complied with.

Air pollution is defined, for clarification, by the Georgia Department of Natural Resources as "the presence in the outdoor atmosphere of one or more air contaminants in quantities or characteristic, and of a duration which are injurious or which unreasonably interfere with enjoyment of life or use of property throughout the state or throughout such areas of the state as shall be affected thereby." Air contaminants can mean any "particulate matter, dust, fumes, gas, mist, smoke, or vapor, or any combination thereof produced by processes other than natural."

Water Quality Control

Water quality control is also maintained by the Director of the Division of Environmental Protection of the Georgia Department of Natural Resources and conforms to the Federal Water Pollution Control Act Amendments of 1972. The purpose of such water control is "to provide enhancement of water quality and prevention of pollution; to protect the public health or welfare in accordance with the public interest for drinking water supplies, conservation of fish, game and other beneficial aquatic life, and agricultural, industrial, recreational, and other beneficial uses."

General regulations, as taken from State Rules and Regulations for Water Quality Control, concerning water control are as follows:

(a) All waters shall be free from materials associated with municipal or domestic sewage, industrial waste or any other waste which will settle to form sludge deposits that become putrescent, unsightly or otherwise objectionable.

(b) All waters shall be free from oil, scum and floating debris associated with municipal or domestic sewage, industrial waste or other discharges in amounts sufficient to be unsightly or to interfere with legitimate water uses.

(c) All waters shall be free from material related to municipal, industrial or other discharges which produce turbidity, color, odor or other objectionable conditions which interfere with legitimate water uses.

(d) All waters shall be free from toxic, corrosive, acidic and caustic substances discharged from municipalities, industries or other sources in amounts, concentrations or combinations which are harmful to humans, animals or aquatic life.

(e) Applicable State and Federal requirements and regulations for the discharge of radioactive substances shall be met at all times.

(f) No man-made physical or other alteration of stream beds that may violate established water quality standards, or reduce the waste assimilative capacity of the streams, will be permitted without the expressed approval of the Environmental Protection Division.

The above regulations are more specific when applied to industrial operations, as follows:

1. For processing and cooling water with or without special treatment; or for any other use requiring water of a lower quality.

   (i) Dissolved Oxygen: No less than 3.0 mg/l at any time.

   (ii) pH: Within the range of 6.0 - 8.5.

   (iii) Toxic Substances, Other Deleterious Materials: None in concentrations that would prevent fish survival or interfere with legitimate and beneficial industrial uses.

   (iv) Temperature: Not to exceed 90°F. At no time is the temperature of the receiving waters to be increased more than 50°F above intake temperature except that in estuarine waters the increase will not be more than 1.5°F. In streams designated as trout or smallmouth bass waters by the State Game and Fish Division, there shall be no elevation or depression of natural stream temperatures.

Mining

Mining of kaolin would be open-pit or surface mining and hence would be regulated by the Georgia Surface Mining Act of 1968. Specific regulatory requirements are left to the discretion of the Surface Mined Land Use Board under the Georgia Department of Natural Resources for the purpose of "the reduction, elimination or counteracting of pollution or deterioration of land, water and air attributable to mining."

In essence three things are required of an operator of a surface-mining firm:

1. He must obtain a license from the Surface Mined Land Use Board each year.

2. He must, with the application for the above mentioned license, submit a land use plan for the area of the mine and include provisions for reclamation of the land. Once this land use plan has been approved it is the responsibility of the mining firm to carry out the plan.

3. He must file a bond with the Surface Mined Land Use Board.

It should be noted that land reclamation can take many directions, depending on the location, the type of soil, the overburden, and the topography of the land involved. Mined land can be reclaimed, for example, by such methods as refilling and eventual use as a building site, or even as pasture land, as a sanitary landfill, for recreation where lakes can be prepared for stocking of fish or for swimming, or as tree farms.

Reclaiming of the land is a matter for consideration from the point of how to reclaim in a manner that will maximize both the owner's return on investment and the public's protection of the resulting surface and environment. Fortunately, technology is now available to restore surface mines to a level perhaps more acceptable than that of the land before mining was carried out.

Pilot Plant Operation

An alumina-from-kaolin pilot plant will naturally contain factors in which there is presently insufficient knowledge to predict the exact environmental impact. As these factors become known, immediate corrective action will have to be taken. Other factors can be projected prior to construction of such an operation and are discussed in the following section.

Processing

The processing operations connected with an alumina-from-kaolin plant must be given environmental consideration in both air and water control. As with the case of land reclamation requirements, there exists appropriate technology to deal with these pollution possibilities, as follows:

1. Calcining of clay takes place in a rotary kiln at temperatures of $800^{\circ} \pm 50^{\circ}C$. Pollution possibilities are dust, fuel oxides (CO_2, etc.), thermal pollution, and water as steam.

2. The leaching stage will be carried out at atmospheric pressure and relatively low temperature. Pollutants here could be the escape of acid either as liquid or gaseous.

3. In flocculating and separating solids the major environmental consideration must be given to the disposal of solids remaining from the leaching. Flocculated silica from the U. S. Bureau of Mines miniplant appears to have the physical and chemical characteristics of sand. The solids, containing the flocculated silica, sand and/or gravel left from the raw clay, and TiO_2 as brookite or anatase, may be processed, at least in part, to recover by-product values. Perhaps the majority may go back as mine fill in the restoration process.

4. In the ion-exchange removal of iron and other metals, the stripping liquids are purified and recycled. Trace acid in the ion-exchange media is removed by separate water wash. Iron is recovered as a high density Fe_2O_3 product.

5. The next step, heating to recover acid and water and produce Al_2O_3, involves substantial energy. Heat is either expended or transferred to another process stage with minimal thermal pollution expected.

   With proper care and design it is considered that acid pollution should be eliminated, both as acid and as fumes. Recovery and recirculation of that acid should solve the problems of pollution and, at the same time, provide certain economies as both acid and heat are conserved.

Exhaust and fume control must be planned by disposing of coal and fly ash. The coal ash can be used in mine refilling and fly ash possibly resold as some commercial product, such as an ingredient in concrete blocks. Gaseous emissions, such as SO_2 and CO_2, could be controlled through proper stack exhausts.

6. In calcining to alpha-alumina, heat dissipation from the product which has been heated to 1000°C must be released, preferably through energy transfer back to one or more of the preceding steps. There will also have to be control of thermal pollution and dust at this point.

7. Other considerations include water supply and wastes, with most water being recirculated, along with other fluids. Any waste water left over will probably be sent to treatment ponds for future recirculation or return to natural form.

Rules and Regulations

Publication of the Georgia Air Quality Control Act, the Georgia Water Control Act, and the Georgia Surface Mining Act in this report is not deemed feasible. Copies of these acts and related published rules and regulations may be obtained from the Environmental Protection Division, Georgia Department of Natural Resources, 270 Washington Street, S. W., Atlanta, Georgia 30334.

APPENDIX

CERTAIN PAYMENT FOR COMMERCIAL PRODUCTION
PLANT PRODUCING ALUMINUM ORE FROM
KAOLIN AUTHORIZED

CERTAIN PAYMENT FOR COMMERCIAL PRODUCTION PLANT PRODUCING ALUMINUM ORE FROM KAOLIN AUTHORIZED.

Proposed Amendment to the Constitution.

No. 127 (House Resolution No. 259-983).

A Resolution.

Proposing an amendment to the Constitution so as to authorize the General Assembly to provide by law for the payment of $250,000 to the first person, firm or corpora- 1672
tion, or combination thereof, which establishes a plant for the commercial production of aluminum ore (alumina or aluminum chloride) from kaolin and produces a minimum of 300,000 tons annually; to provide for the submission of this amendment for ratification or rejection; and for other purposes.

Be it resolved by the General Assembly of Georgia:

Section 1. Article VII, Section I, Paragraph II of the Constitution is hereby amended by adding at the end thereof the following paragraph:

"The General Assembly is hereby authorized to provide by law for the payment of $250,000 to the first person, firm or corporation, or combination thereof, which establishes a plant for the commercial production of aluminum ore (alumina or aluminum chloride) from kaolin and produces a minimum of 300,00 tons annually. The kaolin must be mined in Georgia and the manufacturing plant located in Georgia."

Section 2. The above proposed amendment to the Constitution shall be published and submitted as provided in Article XIII, Section I, Paragraph I of the Constitution of Georgia of 1945, as amended.

The ballot submitting the above proposed amendment shall have written or printed thereon the following:

"( ) YES
( ) NO

Shall the Constitution be amended so as to authorize the General Assembly to provide by law for the payment of $250,000 to the first person, firm or corporation, or combination thereof, which establishes a plant for the commercial production of aluminum ore (alumina or aluminum chloride) from kaolin and produces a minimum of 300,000 tons annually?"

All persons desiring to vote in favor of ratifying the proposed amendment shall vote "Yes". All persons desiring to vote against ratifying the proposed amendment shall vote "No".

If such amendment shall be ratified as provided in said Paragraph of the Constitution, it shall become a part of the Constitution of this State.

A-1458

ALUMINA FROM KAOLIN ENVIROMENTAL CONSIDERATIONS

Economic Development Laboratory
ENGINEERING EXPERIMENT STATION
Georgia Institute of Technology

Project A-1458

ALUMINA FROM KAOLIN
ENVIRONMENTAL CONSIDERATIONS

Prepared for

Georgia Bureau of Industry and Trade

Under a Grant from

The Coastal Plains Regional Commission

by

William C. Ward, Jr.

and

John E. Husted

For additional information contact:

GEORGIA BUREAU OF INDUSTRY AND TRADE

P. O. Box 38097, Atlanta, Georgia 30334

Telephone (404) 656-3572

Economic Development Laboratory
ENGINEERING EXPERIMENT STATION
Georgia Institute of Technology
April 1976

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Acknowledgments

Acknowledgment and appreciation are given for the excellent cooperation and critical review of drafts made by the Director and Staff of the Environmental Protection Division of the Georgia Department of Natural Resources.

The authors also wish to acknowledge the helpful input of the Georgia Bureau of Industry and Trade, including its publication "Environmental Regulations for Georgia Industry" by Roger D. Howard, October 1975.

INTRODUCTION

Purpose of Report

The primary purpose of this report is to provide environmental guidelines through a compilation of relevant environmental regulations that must be considered in determining the feasibility and planning for the development of an alumina-from-kaolin industry in Georgia.

Environmental considerations must be an integral part of any new technology and hence must be a part of industry's planning. The need, therefore, for environmental guidelines for planning and operation of an alumina-from-kaolin industry in Georgia has been apparent. The strong possibility of the development of an alumina-from-kaolin industry in the state within the next 10 years or less is an added incentive.

The first section of this report covers a general overview of the State of Georgia's environmental authorities and procedures. Laws and regulations relating specifically to mining and to the various processing operations involved in the extraction of alumina from kaolin are detailed in the remaining sections.

Previous Alumina Studies

In April 1972 the Industrial Development Division (now the Economic Development Laboratory) of the Engineering Experiment Station at the Georgia Institute of Technology prepared a report entitled Alumina from Kaolin Potentials for the Georgia Department of Community Development (then called the Georgia Department of Industry and Trade).

The 1972 report concluded that the use of bauxite as the only primary source of alumina and aluminum placed the United States in a vulnerable position concerning supplies of this important metal.

The problem was not that the United States lacked adequate sources of aluminum-bearing minerals. The problem had been the economic advantage of the technology of using bauxite versus the economics of technologies of other aluminum-bearing minerals.

The question was what was to be done and how to proceed in implementing an economically competitive, self-sufficient domestic alumina-aluminum supply. The action recommended in the 1972 report was directed toward giving answers to this question.

In November 1974 the Industrial Development Division prepared another report for the Georgia Department of Community Development which addressed the validity of the conclusions drawn and recommendations made in 1972, recounted events that had occurred between 1972 and 1974 which reinforced or warranted changes in those conclusions and recommendations, and discussed new items which influenced recommendations made in the 1974 report.

Among the conclusions drawn in the 1974 report was that the projected relative economics, based on new construction, indicated that bauxite and kaolin as a source of alumina were nearly even. Lead time, however, for testing and constructing an alumina-from-kaolin facility would be at least five years -- and perhaps more. Another conclusion reported in the 1974 study was that technology was considered to be available to satisfy the environmental considerations of an alumina-from-kaolin industry.

Progress in Extractive Methods

At the present time, there are at least three acid extraction methods that may be used to produce alumina from kaolin. The methods are (1) nitric acid, (2) hydrochloric acid, and (3) concentrated sulphuric acid-hydrochloric acid. Each of the acid extraction methods is under serious consideration by one or more aluminum companies. There has been pilot work on nitric acid and there is pilot work on a hydrochloric acid method in progress at the U. S. Bureau of Mines' Metallurgy Research Laboratory in Boulder City, Nevada. The concentrated sulphuric acid method with a hydrochloric acid purification step has been piloted at a miniature level, and a 20-ton-per-day pilot plant is being constructed by Pechiney Ugine Kuhlmann of France.

The mini-pilot work on nitric acid by the U. S. Bureau of Mines at Boulder City is essentially completed. Nitric acid as a means of extraction of alumina from kaolin has received considerable attention. The first published indication that there could be a technological and economic breakthrough that would permit kaolin to be a competitive ore with bauxite was from projections of production costs using Arthur D. Little's nitric acid process patented in 1971.

A hydrochloric acid extraction of alumina from kaolin method was piloted on a five- to seven-tons-per-day level over an 18-month period by the Anaconda Company. Anaconda used Georgia kaolin for its pilot plant work at Anaconda, Montana. The Anaconda work was proprietary, but reports are that although the method was successful, at the time of piloting (circa 1965) the economics were not competitive with a Bayer-bauxite method.

The U. S. Bureau of Mines is currently doing mini-pilot work on stages of a hydrochloric acid method at Boulder City, Nevada. A fully integrated pilot probably will not be completed until later in 1976. At this time, results are not complete, and good technical data concerning any improvements that have been made during the past 10 years are not available.

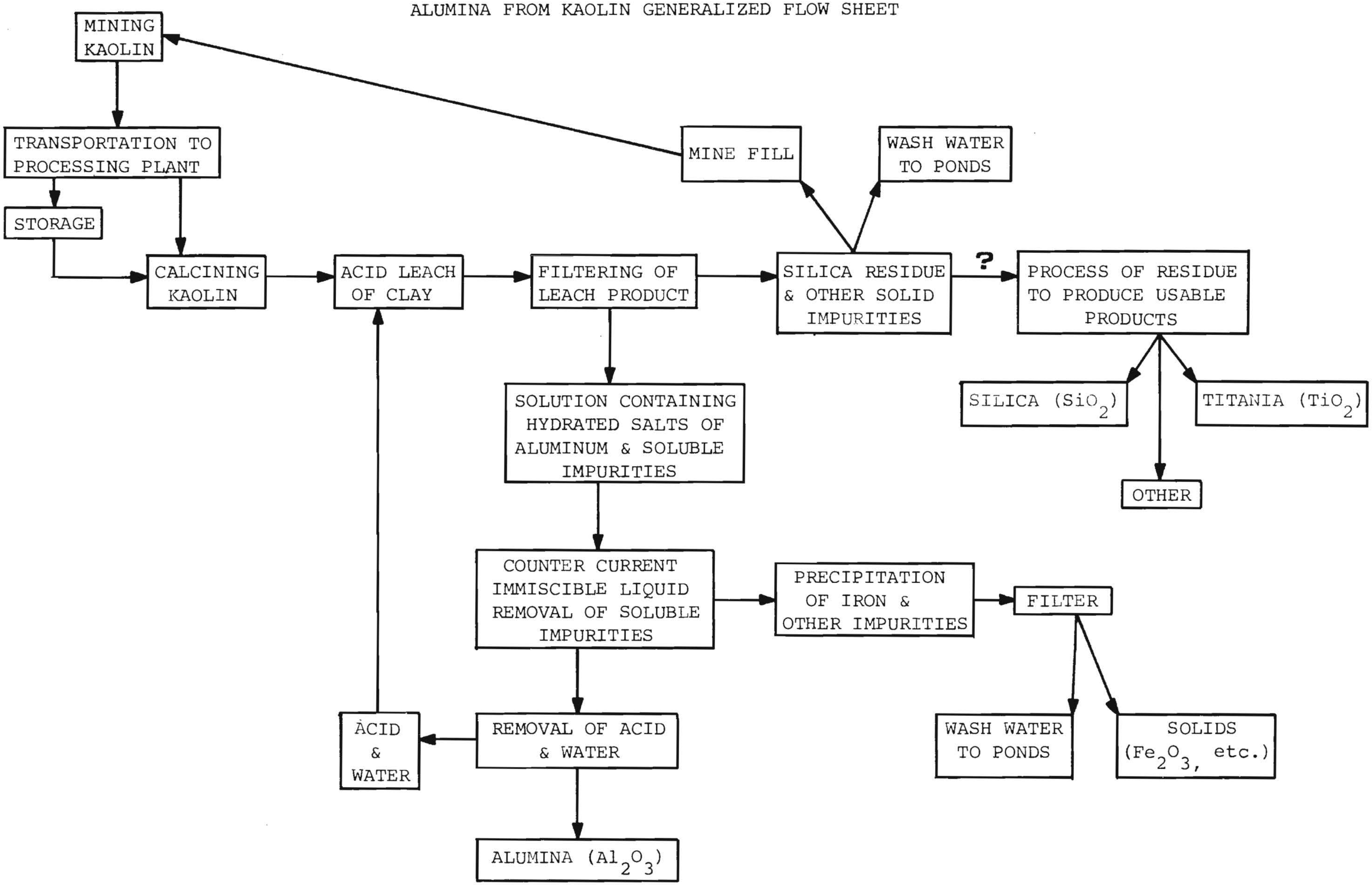
Completion of Pechiney's 20-ton-per-day pilot plant to use the concentrated sulphuric-hydrochloric acid method of production of alumina from kaolin is estimated to be summer of 1976.

Figure 1 is a generalized flow sheet for the production of alumina from kaolin. This figure is correct for the state of the art as currently published. Differences that may be encountered will be in the acid or acids used.

Processes that may be included in Figure 1 consist of closed systems in which the acids and water are recovered and recirculated back into the leach and digestion system. Hence, the greater the efficiency of the systems, the fewer the environmental problems that will be encountered.

Figure 1

ALUMINA FROM KAOLIN GENERALIZED FLOW SHEET



ENVIRONMENTAL PROCEDURES

General

The federal Environmental Protection Agency (EPA) was formed by executive reorganization, with Congressional approval, and became effective December 1970.

Initially, and as specifically enumerated in the original act, there were twenty-six industrial categories for which environmental standards were to be established. This has since been expanded to thirty-seven with the possibility of others in the future. The standards were of two types, each with separate goals and completion dates. The standards have been and are being obtained chiefly through the use of consultants.

The standards to obtain "Best Practical Control Technology Currently Available" have had a target date of July 1, 1977. Some industry categories may have an extension of that date.

The standards to obtain "Best Available Technology Economically Achievable" have had a target date of July 1, 1983.

Among the latest industrial categories is "Ore Mining and Dressing Point Source Category" (Federal Register, Thursday, November 6, 1975, pp. 51722-51733). This contains a subsection on "Bauxite and Other Aluminum Ores" which will establish current approved minimum standards, subject to change at a later date.

The State Executive Reorganization Act of 1972, as amended, created the Georgia Department of Natural Resources and under this Department there was created the Environmental Protection Division.

Georgia is among the states having a major input into the establishment of standards and state government implementation of the federal program of EPA. Effective July 1, 1974, Georgia was authorized to implement the National Pollutant Discharge Elimination System (NPDES) Permit Program. The state is empowered to issue environmental practice permits which also satisfies federal requirements. The Georgia Environmental Protection Division is therefore the single agency for environmental practice in Georgia and processes both applications and permits. The federal EPA has an overview responsibility to assure that the State's air and water quality programs meet all federal requirements.

Currently, a major environmental impact study is not required. Detailed engineering studies are required.

Authorities

The Environmental Protection Division administers and establishes the rules and regulations as required by the appropriate acts concerning environmental protection.

The Environmental Protection Division derives its authority from six laws, namely:

Air Quality Control Act
Solid Waste Management Act
Surface Mining Act
Ground Water Use Act
Water Quality Control Act
Water Supply Quality Control Act

The Surface Mining Act was amended by the 1976 Georgia General Assembly to bring it into agreement with the other five acts. The amended Act becomes effective July 1, 1976, and is quite changed from the Act it replaces.

Contact Personnel

Persons to be contacted within the Environmental Protection Division of the State of Georgia concerning the above acts are:

J. Leonard Ledbetter
Director, Environmental Protection Division
(404) 656-4713

Robert Collom
Chief, Air Protection Branch
Environmental Protection Division
(404) 656-6900

Moses N. McCall, III
Chief, Land Protection Branch
Environmental Protection Division
(404) 656-2833

Gene B. Welsh
Chief, Water Protection Branch
Environmental Protection Division
(404) 656-6593

All of the above are located within the:

Georgia Department of Natural Resources
270 Washington Street, S. W.
Atlanta, Georgia 30334

Procedures

In the discussion to follow, brief statements will be made concerning Georgia's environmental practice, with general statements concerning application to an alumina-from-kaolin industry. The substance of this portion of the report is to inform industry that may be seeking to use kaolin as an ore of aluminum on how to apply for permits and the general procedures to be followed by such companies.

An important aspect of obtaining a permit or license covering environmental practices in Georgia is that only one state office has to be visited to apply, and the application automatically takes care of any permits which may be required by federal or state laws. The State of Georgia is empowered to deal with the Federal Environmental Protection Agency regarding issues pertaining to each company, where it is necessary.

All environmental practice permits in Georgia are obtained from the Environmental Protection Division. This obviously is a convenience to any industry planning to operate in the state. The laws of the state and of the federal government, as they are set up in Georgia, designate the state as the agency to deal with the federal government on environmental matters. This alleviates many time-consuming procedures, as well as the possibility of conflicting interest where multiple offices need to be used for application for permits for environmental practices.

For any company proposing to enter into the production of alumina from kaolin in Georgia, the initial step would be for the appropriate company officials and engineers to schedule an informal discussion with the Director, Environmental Protection Division, Georgia Department of Natural Resources.

The purpose of the meeting will be to determine what policies apply, the information to be provided, and the procedures that the company must follow to be in compliance with Georgia law. At this meeting, the Director will furnish the necessary forms and instruct the company officials as to the standards to be met and the information that will be required for the formal presentation of plans for the project.

A later formal meeting should be scheduled with the Director, Environmental Protection Division, Georgia Department of Natural Resources. The following are to be presented at the formal meeting:

a. A detailed engineering report to include meeting technical standards, as established, a plan of implementation, and appropriate drawings.

b. Completed forms obtained at informal meeting.

c. Overall concepts of dealing with environmental concerns regarding raw materials, effluents, and finished product.

The Director must respond to the formal application for a permit within 60 days.

Discretionary power is given to the Georgia Environmental Protection Division to issue the permit after consideration of information presented at the formal meeting or to request further information or to hold public hearings.

ENVIRONMENTAL CONSIDERATIONS: MINING

Characteristics of Mining

Mining kaolin for the production of alumina will differ in two significant ways from conventional kaolin mining for paper coating or filler purposes. These are the differences in mining rates and end use.

The mining of kaolin for the production of alumina on a fully commercial basis will probably involve a minimum of 3,000 tons per day and a maximum of 12,000 tons per day of kaolin for each alumina plant. This is based on a commercial plant range of capacities of 300,000 tons to 1,000,000 tons of alumina product per year. This rate of mining is much greater than that in conventional mining of kaolin at present.

The other major difference is that kaolin which is mined for filler or paper coating is used as kaolin. In the use of kaolin for the production of alumina, roughly one third of the kaolin is alumina and two thirds is silica. Either most or all of the silica residue will be returned to the mines for mine fill. If all of the silica is returned to the mine for fill, this means that roughly two thirds of the material taken out can be returned in the form of silica. This in turn means that the potentially large holes being left, as may be envisioned by the previously mentioned rate of mining, will not be as large because of the silica fill. Even if some of the silica residue is processed to recover the titania content or some of the silica for purification for use in various applications (either as an abrasive or treated to secure the silicon from the silica), the volume of this should still leave substantial amounts of residue material to be returned to the mines.

The silica residue obtained in the U. S. Bureau of Mines' pilot plant work at Boulder City, Nevada, was coagulated into a product resembling a coarse sand. When silica in this form is returned to a mine fill, it should behave as a coarse sand with the same load-bearing and drainage properties of such a sand. A mix of this material with the overburden being returned to the fill should produce a sandy loam that should be ideal for agricultural purposes. As projected, restored land after the mining of kaolin for alumina could be a better soil for agriculture and recreation than the land that existed before.

Regulation of Land Reclamation

The Georgia Surface Mining Act of 1968, as amended, is directed toward land reclamation related to surface mining and not to control of mining practice. Methods of land reclamation, subject to laws and regulations as abstracted below, are the prerogative of the operator.

REGULATION OF LAND RECLAMATION

LEGAL REFERENCES:	For a detailed legal citation of the information summarized below, see:
	o GEORGIA CODE, CHAPTER 43-14. GEORGIA SURFACE MINING ACT OF 1968, as amended.
	o OFFICIAL COMPILATION RULES AND REGULATIONS OF THE STATE OF GEORGIA, CHAPTER 391-3-3 Amended.
PERMIT:	o A permit must be obtained in order to operate a surface mine.
	o The application for a permit shall be made on a form provided by the Director, Environmental Protection Division. Said permit shall be issued on evidence, satisfactory to the Director, of compliance with the provisions, rules and regulations pursuant thereto. Issuance of a permit will be conditioned upon the permittee's compliance with the approved Mine Land Use Plan.
MINED LAND USE PLAN:	o The Mined Land Use Plan, which must be submitted with the permit application, has to indicate how the operator is going to restore the land to a useful condition acceptable to the Environmental Protection Division.
	o Each operator is given a good deal of discretion in the particular way he wants to restore the land. However, the plan must show that the operator will take measures to protect the health and welfare of the people from the adverse effects of surface mining. Some of the measures are as follows:
	Grade all peaks, ridges, and valleys resulting from surface mining and backfill all pits and trenches resulting from the same.
	No natural creeks, streams, rivers, lakes, or other bodies of water are to be altered in

course or relocated unless authorized in the operator's approved Mined Land Use Plan.

No operator on his own initiative shall construct any protective barrier, dam, berm, silt pond, or similar structure as a part of his surface mining operation without the prior approval of the EPD.

- The Land Use Plan is to include, but is not limited to, a description of:

  Company and minerals or materials to be mined
  Mining methods
  Lands and community to be affected
  Reclamation objective
  Schedule of mining and reclamation, including time to accomplish reclamation
  Affected acreage
  Natural drainage and water disposal
  Provisions for erosion and siltation control
  Protection of contiguous natural resources
  Topsoil use
  Overburden (spoil) and refuse placement or use
  Backfilling
  High wall reduction
  Grading and sloping
  Lake development
  Site clean up
  Revegetation of reclaimed lands
  Location map of affected lands
  Land use map (or accurate aerial photographs)

- Once the structures, equipment, stockpiles, mining refuse, and all other materials associated with surface mining are removed or disposed of, the affected land will be restored to the condition stated in the mining operator's approved Mined Land Use Plan.

- All restored lands must have a neat, clean appearance and contain a high quality, permanent vegetative cover, except those specifically exempted by the Environmental Protection Division.

BONDING REQUIREMENT:

- The Director, Environmental Protection Division, has the authority to exempt a mining operator from the bonding requirement for each Mined Land Use Plan. Exemption from the bonding requirement is obtained by application to the Director and is granted at the Director's discretion.

- Unless a mining operator is specifically exempted from bonding by request to the Director, a bond must be filed within 60 days from the date of being furnished approved surety bond forms by the Division. An amended Mined Land Use Plan, upon approval, is similarly subject to bonding requirements.

- Any bond filed with the Director shall be written by surety approved by the Director and authorized to transact business in the State of Georgia. Bond shall be fixed by the Director in an amount not less than $100 nor more than $1,000 per acre, or fraction thereof, of the area of affected land.

- The bond shall be payable to the Governor and conditioned upon the faithful performance of the statutory rules and regulations pertaining thereto.

- Mining operators shall have the option of posting bond, government securities, cash, or any combination thereof, on each mined area. The surety shall be held by the Division until the affected land is satisfactorily reclaimed in the opinion of the Director, at which time surety will be terminated by cancelling bond and/or return of any government securities or cash.

- If the mined area is not satisfactorily reclaimed, the Director may expend as he deems appropriate such portion of the bond as is necessary to complete the mining operator's responsibilities under the Mined Land Use Plan.

Control of Erosion and Sedimentation

In addition to the surface mining regulations, regulations relating to erosion and sedimentation will also apply in a surface mining area and also where noncovered bulk storage of kaolin is used at plant sites or other areas.

The following abstract pertaining to the control of erosion and sedimentation is quoted from "Environmental Regulations for Georgia Industry."

CONTROL OF EROSION AND SEDIMENTATION

The EROSION AND SEDIMENTATION ACT OF 1975 (GEORGIA CODE, CHAPTER 5-23A) allows counties and municipalities to regulate soil erosion and sediment deposition onto lands and into water of the State. The State already has this authority under its Water Quality laws and is attempting to share this responsibility with local governments.

The *Act* has given the governing authority of each county and municipality until April 24, 1977 to adopt a comprehensive ordinance which sets up procedures that regulate land-disturbing activities.

These activities are defined as those which may cause soil erosion from water or wind and the movement of sediments into water or onto lands of the State. They include but are not limited to clearing, dredging, grading, excavating, and the transporting and filling of lands other than federal lands.

This comprehensive ordinance must at least contain these requirements:

- o Stripping of vegetation, regrading and other development activities shall be conducted in such a manner so as to minimize erosion.
- o Cut-fill operations must be kept to a minimum.
- o Development plans must conform to topography and soil type so as to create the lowest practical erosion potential.
- o Whenever feasible, natural vegetation shall be retained, protected and supplemented.
- o The disturbed areas and the duration of exposure to erosive elements shall be kept to a practicable minimum.
- o Disturbed soil shall be stabilized as quickly as practicable.
- o Temporary vegetation or mulching shall be employed to protect exposed critical areas during development.
- o Permanent vegetation and structural erosion control measures must be installed as soon as practicable.
- o To the extent necessary, sediment in run-off water must be trapped by the use of debris basins, sediment basins, silt traps, or similar measures until the disturbed area is stabilized.
- o Adequate provisions must be provided to minimize damage from surface water to the cut face of excavations or the sloping surfaces of fills.
- o Cuts and fills may not endanger adjoining property.
- o Fills may not encroach upon natural water courses or constructed channels in a manner so as to adversely affect other property owners.
- o Grading equipment must cross flowing streams by the means of bridges or culverts except when such methods are not feasible and provided, in any case, that such crossings are kept to a minimum.

Land-disturbing activities governed by comprehensive ordinances do not include:

- o Surface mining (as defined in the GEORGIA SURFACE MINING ACT OF 1968), (GEORGIA CODE, CHAPTER 43-14).

- o Granite quarrying and land clearing for such quarrying.

- o Minor land-disturbing activities such as home gardens, individual home landscaping and other related activities which result in minor soil erosion.

- o Construction of single-family residences when such are constructed by or under contract with the owner for his own occupancy.

- o Agricultural practices which involve such activities as harvesting, planting of pasture land, livestock and poultry management practices.

- o Any project carried out under the technical supervision of the Soil Conservation Service of the U. S. Department of Agriculture.

- o Activities which involve a land change of five acres or less or the movement of not more than 500 cubic yards of land. This exemption does not apply to any land-disturbing activity within 200 feet of the bank of any major stream or river which drains at least a land area of 100 square miles.

- o Construction or maintenance projects undertaken or financed in whole or in part by:

  Georgia Department of Transportation
  Georgia Highway Authority
  Georgia Tollway Authority
  Any county or municipality

- o Activity for which bids have been let or a construction contract signed prior to effective date of local ordinance or local government board regulation, provided that the activity is completed within 12 months of such effective date.

If the county or municipality does not enact this comprehensive ordinance by April 24, 1977, the Department of Natural Resources, in cooperation with the State Soil and Water Conservation Committee, will adopt rules and regulations which control land-disturbing activities. The rules and regulations will contain the same requirements that must be in the comprehensive ordinance.

By April 24, 1977, any industry that engages in land-disturbing activities will have to obtain a permit from either the county or municipality (if an approved ordinance is in effect), or from the

Environmental Protection Division of the Department of Natural Resources. The industry applying for a permit must submit erosion and sediment control plans and supportive data which indicate that the land-disturbing activity will be carried out so as to meet the minimum requirements contained in the ordinance or rules and regulations. The permit will be issued only when the applicant's plan has been reviewed by the Soil and Water Conservation District and does in fact show that these requirements can be met. Specific conditions may be imposed with a permit.

Until April 24, 1977, enforcement of the minimum requirements for the prevention of soil erosion and sedimentation will be by counties and municipalities. After this date, the Department of Natural Resources will have enforcement procedures for its own rules and regulations but only for those counties and municipalities which do not have ordinances in effect.

ENVIRONMENTAL CONSIDERATIONS: PROCESSING

Input into and discharge from the alumina-from-kaolin process may require environmental safeguards. Such inputs and discharges are discussed in this section with applicable abstracts of Georgia law and regulations.

Water Supply

Water consumption of the alumina-from-kaolin process has been variously estimated at between 5,000,000 and 21,000,000 gallons per day. The variance results from different operating capacities and different acids that may be used in the processing. The minimum water requirement is estimated to be on an order of 5,000,000 gallons per day for a 300,000 tons per year output of alumina product. The larger figure represents a maximum capacity plant of up to 1,000,000 tons per year of alumina. Unknown at this point is the efficiency of the water collection and acid collection system which will recirculate the recovered water in the processing. There also will be recirculation of water from storage ponds where wash water will be discharged. Hence, the actual daily requirement of new water is not known.

Below is an abstract of the regulation of the use of ground water.

REGULATION OF GROUND WATER USE

LEGAL REFERENCES: For a detailed legal citation of the information summarized below, see:

- o GEORGIA CODE, CHAPTER 17-11. GROUND WATER USE ACT OF 1972, as amended.
- o OFFICIAL COMPILATION RULES AND REGULATIONS OF THE STATE OF GEORGIA, CHAPTER 391-3-2.

PERMIT:

- o Any industry, unless exempted by law, must obtain permit to withdraw, obtain, or utilize ground water in excess of 100,000 gallons per day for any purpose.
- o Permit requirements differ according to whether the ground water will be put to either a consumptive or nonconsumptive use.
- o During the early planning stages for a proposed ground water withdrawal, and in any case prior to the start of well construction, the intended

user should request a conference with the Environmental Protection Division (EPD).

- Representatives of the EPD will determine the acceptability of proposed wells, the aquifers to be utilized, the well spacing and well depth, and the amount and intended ground water use.

- After considering all the factors, the EPD may issue a letter of concurrence setting forth such terms and conditions as it considers necessary.

- Such a letter is not mandatory, but the user proceeds at his own risk if he fails to obtain it.

- After completing construction of the well or wells, but before water use begins, the intended user must apply for a ground water use permit on forms furnished by the Division.

- The application for a permit should at least include:

  Owner identification data
  Aquifer(s) utilized
  Amount and purpose of ground water use
  Detailed well construction data including drillers' logs
  Well location(s) (latitude and longitude and location map)

- The Environmental Protection Division will consider the following factors when it decides whether the permit should be granted:

  Number of persons using an aquifer and the object, extent and necessity of their respective withdrawals or uses.

  Nature and size of the aquifer.

  Physical and chemical nature of any impairment of the aquifer.

  Probable severity and duration of such impairment under foreseeable conditions.

  Injury to public health, safety or welfare which results if such impairment were not prevented or abated.

  Businesses or activities to which the various uses are related.

Importance and necessity of the uses claimed by permit applicants.

Extent of any injury caused to other water uses (including public use).

Diversion from or reduction of flows in other water courses or aquifers.

Any other relevant factors, such as, but not limited to, the best geologic and hydrologic information available of the aquifer or ground water system of the area.

- o Duration of Permit: Permits are normally issued for ten years, but a longer period may be authorized by the EPD to provide for reasonable amortization of the applicant's water withdrawal and water using facilities.

CONSUMPTIVE-USE PERMIT: Some of the conditions that may be imposed along with the granting of a consumptive-use permit include:

Total permitted well depth in feet.

Aquifer(s) or ground water system to be utilized.

Maximum pumping rate.

Pumping level (elevations below which water may not be pumped).

Amount of ground water to be withdrawn or used.

Well spacing to minimize well interference.

Time of withdrawal.

Require observations or monitoring well(s) be installed for monitoring ground water levels and water quality.

NONCONSUMPTIVE-USE PERMIT:

- o None of the above conditions may be imposed on the user once a nonconsumptive-use permit is granted.
- o Nonconsumptive use means the use of water withdrawn from the ground water system or aquifer in such a manner that it is returned to the ground water system or aquifer from which it was withdrawn without substantial diminution in quantity or substantial impairment in quality at or near the point from which it was withdrawn.

- In determining whether a use of ground water is nonconsumptive the Environmental Protection Division considers (based on the best geologic and hydrologic information available) whether any material injury to other water users of the area by reason of the reductions of water pressure in the aquifer or system has not been adequately compensated by the permit applicant who caused or substantially contributed to this injury.

- Granting of a nonconsumptive-use permit does not imply consent to inject any waste or pollutant material into the ground water system.

GROUND WATER USE REPORT:

- Once a permit is granted, the user must file semiannually with the Environmental Protection Division a certified statement (ground water use report) on forms furnished by the Division which states:

  Quantities of water withdrawn and/or injected
  Sources of water
  Nature of the use
  Static and pumping water level in selected wells

- A specific conductance analysis of raw water is required annually.

DEWATERING WELLS:

- A permit will not be required for the withdrawal of ground water in excess of 100,000 gallons per day if:

  It involves dewatering the subsurface rock to a depth of not more than 30 feet, or to a greater depth if approved by the EPD, and

  Is for the purpose of construction of trenches for sewer or water pipes, or excavation for foundations, or utility construction, and

  Is for a period of not more than 60 days, unless an extension of time is approved by the EPD.

SALT WATER ENCROACHMENT OR DETERIORATION OF WATER:

To protect against salt water encroachment or the deterioration of the water quality of the ground water, the Environmental Protection Division may require various control measures, a list of which can be found in the RULES AND REGULATIONS.

INSPECTIONS AND INVESTIGATIONS:	EPD has the power to enter at reasonable times any private or public property for the purpose of inspecting or investigating conditions relating to the use of ground water.
OTHER LAWS:	Industries should be aware that there might be municipal or county ordinances which relate to the regulation of ground water use.

Air Emissions

A potential area in the alumina-from-kaolin process in which air quality control regulations would apply is in the calcination of the clay, where proper precaution will need to be observed to meet the specific emission standards. In the water-chemical treatment of the kaolin from leaching to the final recovery of the alumina product, care must be exercised so that there is no escape of acid vapors or excess steam in the process. The process will be designed as a closed system in order to recover both the water and the acid. The economics of the process require as complete a recovery of the acid as possible in order that the process may be competitive with the Bayer-bauxite process. From the standpoint of air quality control, this means that it will be a matter of design and maintenance to prevent any unplanned air emissions.

An abstract of air quality control regulations is set forth below.

AIR QUALITY CONTROL

LEGAL REFERENCES: For a detailed legal citation of the information summarized below, see:

- GEORGIA CODE, CHAPTER 88-9. AIR QUALITY CONTROL ACT, as amended.
- OFFICIAL COMPILATION RULES AND REGULATIONS OF THE STATE OF GEORGIA, CHAPTER 391-3-1 Amended.

PERMITS: Granting of a permit depends on the industry's demonstrable capability to meet specific standards found in the RULES AND REGULATIONS.

- *Construction Permit:* A permit is required prior to construction or modification of any facility which may result in air pollution.
- *Temporary Operating Permit:* Contains a compliance schedule specifying steps to be followed to achieve final compliance with the *Act*, rules and regulations.

- *Operating Permit:* Permit application is required within 30 days after commencement of operations. Permit is issued if final compliance with the *Act*, rules and regulations is achieved.

- The permit will specify the conditions under which the facility must be operated so as to comply with the *Act*, rules and regulations.

- Consulting the Air Protection Branch, prior to permit application, is recommended.

EMISSION STANDARDS: Specific emission standards exist for:

Smoke
Incinerators
Fuel-burning equipment
Particulate emission from manufacturing processes
Fluoride
Sulfur Dioxide
Nitric acid plants
Sulfuric acid plants
Nitrogen oxides
Conical burners
Fugitive dust
Cupola furnaces for metallurgical melting
Particulate emissions from kaolin and fuller earth processes
Particulate emissions from cotton gins

- Monitoring: Monitoring and reporting of emissions by industry may be required by EPD if conditions warrant.

AMBIENT AIR STANDARDS: Industries must also meet air standards relating to the concentration of pollutants in the air immediately surrounding the plant. Concentration standards exist for:

Sulfur dioxide
Particulate matter
Carbon monoxide
Total oxidants
Non-Methane hydrocarbons
Nitrogen dioxide

OPEN BURNING:

- Prohibited. Exceptions allowed by State.

FEDERAL STANDARDS: The Federal Environmental Protection Agency's (EPA) air standards are met when the industry complies with Georgia's air standards. It is suggested that consultation with the State agency occur if there are specific questions.

INSPECTIONS AND INVESTI-GATIONS:	EPD has the power to enter at reasonable times any private or public property for the purpose of inspecting and investigating conditions relating to air pollution and obtaining samples of emissions.

Liquid Discharge

Liquid discharge will take place in the washing of the silica residue from the leaching process and from the washing that will take place in the removal of the impurities in the immiscible liquid series. Wash water from both of these areas will probably be discharged into a pond and the water eventually recirculated. It should be emphasized that no acid discharge is envisioned, since it is essential that the acid be recovered as fully as possible in the closed system. There could be some acid in the wash water from both the silica residue and the impurity separation. This will probably need to be neutralized before entering into the pond system.

Surface water runoff entering streams is controlled by federal and state law. In addition to water quality control regulations, the regulations concerning sedimentation quoted under the section on mining also apply.

An abstract of water quality control regulations is set forth below.

WATER QUALITY CONTROL

LEGAL REFERENCES: For a detailed legal citation of the information summarized below, see:

- GEORGIA CODE, CHAPTER 17-5. GEORGIA WATER QUALITY CONTROL ACT, as amended.
- OFFICIAL COMPILATIONS RULES AND REGULATIONS OF THE STATE OF GEORGIA, CHAPTER 391-3-6.

PERMIT:

- The granting of a discharge permit depends on the industry's demonstrable capability to meet specific standards found in the RULES AND REGULATIONS.
- A discharge permit is required to operate any system for the disposal of sewage, industrial wastes, or other wastes into the water.
- The application for such discharge permit should include:

  Complete engineering reports
  Schedule of progress
  Plans

Specifications
Maps
Measurements
Quantitative and qualitative determinations
Records
All other information as the Environmental Protection Division may require

- Georgia is authorized to issue the *NPDES* permit.

APPROVAL FOR CONSTRUCTION:

- Any industry that desires to erect, modify, or alter a sewerage system must obtain approval of any plans, specifications and related materials for such system prior to commencement of construction.

- Engineering reports which are submitted must be prepared by a professional engineer competent in the treatment of water pollutants and must contain:

  Information regarding the existing sewerage system, if applicable.

  Characteristics of existing pollutants and existing or proposed treatment of such pollutants.

  Demonstration of the need for the proposed sewerage system.

  Evaluation of alternatives to define the most cost effective method for meeting established effluent limitations, water quality goals.

  Results to be expected from treatment process.

  Sufficient maps, charts, tables, calculations, basis of design data and graphs to make the report readily understandable.

  An operation and maintenance program description.

  Such other pertinent engineering information as the Environmental Protection Division (EPD) may require.

- Plans and specifications submitted to the EPD for a sewerage system shall include the following:

  Map showing area to be served by the sewerage system.

  Profiles of proposed sewers.

Construction details of manholes and other special sewer structures.

General and detail plans for the treatment facility.

Complete design data for the treatment facility plans, to be submitted in duplicate on forms specified by the Division.

Specifications for the construction of the sewerage system.

Such other plans and specifications as the Division may require.

- o General map plans submitted to the EPD for a sewerage system shall include the following:

  Map plan that shows the entire area to be served.

  All existing and proposed streets in the area to be served; surface elevators at all street intersections, etc.

  Clear designation on the plan by suitable symbols of all sewer appurtenances, including but not limited to, manholes, siphons and pumps.

  Such other information as the EPD may require.

- o Sewer plans and profiles submitted to EPD for a sewerage system shall include the following:

  Sewers and force mains, drawn at a scale that shows the profile for all manholes, siphons, railroad crossings, street or stream crossings, elevations of stream beds, normal stream water levels, and sizes and grades of sewers which show surface elevations and sewer invert elevations.

  Detailed drawings of all sewer appurtenances, including but not limited to, manholes, inspection chambers, siphons, lift stations, and any special structures to accompany the sewer plans. Detail drawings shall be to a scale suitable to clearly show the design details.

- o Plans for treatment facilities submitted to the EPD shall include the following:

General plan that clearly identifies the exact location of the facilities, areas reserved for future expansion, access roads to various units, etc.

Detail plans which show longitudinal and traverse sections sufficient to explain the construction of each treatment unit.

Flow measuring devices at appropriate points in the plan. Sampling and recording devices may be required by the EPD when deemed necessary.

Such other information as EPD may require.

CONSULTATION:

- It is highly recommended that the industry applying for a discharge permit or seeking approval for the proposed erection, modification or alteration of a sewerage system consult with the Environmental Protection Division in order to work out a system which will enable him to comply with the specific environmental standards. In any event, the EPD may request a conference with the industry before it submits any application for a permit, or a proposal for construction.

- The EPD has the obligation to supply the industry with technical and scientific information as may be helpful in reducing or eliminating the polluting effects of the discharge. Yet the responsibility for development and application of means of preventing pollution rests with the company causing the pollution.

GENERAL CRITERIA FOR ALL WATERS:

- All waters shall be free from:

  Materials which will settle to form sludge deposits that become putrescent, unsightly or otherwise objectionable.

  Oil, scum and floating debris in amounts sufficient to be unsightly or to interfere with legitimate uses.

  Material which produces turbidity, color, odor or other objectionable conditions which interfere with legitimate water uses.

  Toxic, corrosive, acidic and caustic substances discharged in amounts, concentrations or combinations which are harmful to humans, animals or aquatic life.

- Applicable State and Federal requirements and regulations for the discharge of radioactive substances shall be met at all times.

- No man-made physical or other alteration of stream beds that may violate established water quality standards, or reduce the waste assimilative capacity of the streams, will be permitted without the expressed approval of the Environmental Protection Division.

WATER USE CLASSIFICATIONS:

- The Environmental Protection Division has established water use classifications as follows:

  Drinking water supplies
  Fishing, propagation of fish, shellfish, game and other aquatic life
  Recreation
  Agricultural
  Industrial
  Navigation
  Wild river
  Scenic river
  Urban stream

- There are different standards applicable to each specific water usage which deal with the following areas of regulation:

  Amount of bacteria that may be discharged into the water

  Dissolved oxygen level of the water

  pH range of the water

  Temperature level of the water

  Presence of toxic waste and other deleterious materials

  Presence of floating solids, settleable solids, sludge deposits or any taste, odor, or color producing substances

  Presence of sewage, industrial or other wastes

  Any other areas that are specifically dealt with in the RULES AND REGULATIONS

INSPECTIONS AND INVESTIGATIONS:

The Environmental Protection Division (EPD) has the power to enter at reasonable times any private or public property for the purpose of inspecting and investigating conditions relating to water pollution.

MONITORING, RECORDING AND REPORTING REQUIREMENTS:	Where a person discharges pollutants into the water authorized by the permit, EPD may require the person to: Establish and maintain records Make reports Install, use and maintain monitoring equipment of methods including, where appropriate, biological monitoring methods Sample such discharge, in accordance with such methods, at such localities, at such intervals, and in such manner as the EPD shall prescribe Provide such other information as the EPD may reasonably require
LOCAL WATER QUALITY CONTROL:	The corporate authorities of the cities and towns in Georgia have the power to prohibit the throwing or depositing of any substance in navigable waterways within their jurisdictions which they consider dangerous to navigation or injurious to vessels or to property along such navigable waters. (See GEORGIA CODE, CHAPTER 80-1).

Solid Waste

Solid waste in the alumina-from-kaolin process will consist of the residue from the leaching process and precipitated material taken out of the immiscible liquid series in the removal of impurities. As previously stated, it is envisioned that most -- if not all -- of the solid waste from the leaching will be returned to the mine area as fill.

However, since some solid waste management will be involved, an abstract of the appropriate regulations is quoted below.

SOLID WASTE MANAGEMENT

LEGAL REFERENCES:	For a detailed legal citation of the information summarized below, see: o GEORGIA CODE, CHAPTER 43-16. SOLID WASTE MANAGEMENT ACT. o OFFICIAL COMPILATION RULES AND REGULATIONS OF THE STATE OF GEORGIA, CHAPTER 391-3-4 Amended.

PERMIT: It should be emphasized that the granting of a permit depends on the industry's demonstrable capability to meet specific standards found in the RULES AND REGULATIONS. A permit is required for these solid waste activities:

Storage
Collection
Transportation
Utilization
Processing
Disposal
Disposal facility construction
Disposal facility operation

PROHIBITED ACTS:

- Handling of solid waste which:

  Creates a nuisance
  Contributes to insect and rodent infestation
  Contributes to the harboring or feeding of animals
  Impairs the quality of the environment
  Creates other hazards to the public health

- Burning of solid waste, except by an approved method.

- Permitting scavenging at a disposal site.

- Open dumping.

- Hazardous wastes and sludges not handled in accordance with a written, approved procedure.

- Disposal of special wastes without an approved proposal.

- Site closures without prior 30-day written notice and approved closing procedures.

- Failure to maintain closed sites for a period of one year, with special attention to erosion control and development of adequate vegetative cover.

EXEMPTIONS:

- Disposing of solid wastes originating from an individual's own residence onto land or facilities owned by him, when disposal of such does not thereby adversely affect public health.

- Disposing of livestock feeding facility waste from facilities with a total capacity of up to 1,000 cattle or 5,000 swine.

o Livestock feeding facility regardless of total per head capacity, if an approved waste disposal system is provided that can properly dispose of runoff from a "ten year storm."

o Use of poultry or other animal manure for fertilizer.

GUIDELINES: GUIDELINES that can assist industries in complying with the RULES AND REGULATIONS are available from the Solid Waste Management Section. Five GUIDELINES are available:

Sanitary landfill or landfill disposal of liquid, semi-solid, and industrial sludge wastes.
Hazardous solid wastes.
Control of flies and odors on caged layer poultry farms.
Highly putrescible solid wastes.
Sanitary landfill disposal of solid latex wastes.

COLLECTION AND TRANSPORTATION:

o Owners or occupants are responsible for the collection and transportation of solid waste accumulated on their property, unless the services of a licensed collector have been engaged.

o Vehicles transporting putrescible waste must be covered, substantially leakproof, durable, and of easily cleanable construction.

o Vehicles must be cleaned frequently and maintained in good repair.

o Vehicles must be loaded, covered, and moved in such manner as to prevent littering and spillage.

o Special precautions must be taken regarding these areas of transfer station maintenance:

Scattering
Accumulation
Floor maintenance
Sewage solids
Hazardous wastes
Dust
Pests

DISPOSAL:

o Sanitary Landfill Operations. Special precautions must be taken regarding:

Unloading
Spreading and compaction
Daily cover

Intermediate cover
Final cover
Grading and drainage
Continuity of operation
Environmental protection
Hazardous waste
Supervision
Limited access
Litter control
Fire protection

- o Landfill Operations. Special precautions must be taken regarding:

  Spreading and compaction
  Cover
  Grading and drainage
  Environmental protection
  Limited access
  Fire protection

- o Other Disposal Operations. Special approval must be obtained.

PROCESSING:

- o Incineration or pyrolysis. Special precautions must be taken regarding:

  Supervision
  Residue
  Waste water
  Air quality
  Posted information
  Cleanliness and sanitation
  Fire control

- o Shredding. Special precautions must be taken regarding:

  Supervision
  Shredding
  Waste water
  Air quality
  Posted information
  Cleanliness and sanitation
  Fire control

- o Baling. Special precautions must be taken regarding:

  Supervision
  Bale size
  Waste water
  Air quality

Posted information
Cleanliness and sanitation
Fire control

- Reclamation and Recycling. Special precautions must be taken regarding:

  Supervision
  Storage
  Incineration
  Posted information
  Fire control

- Composting. Special precautions must be taken regarding:

  Supervision
  Posted information
  Residue
  Cleanliness and sanitation
  Fire control

- Other Processing Operations. Prohibited unless special approval obtained.

INSPECTIONS AND INVESTIGATIONS:

- EPD has the power to enter at reasonable times any private or public property for the purpose of inspecting or investigating conditions relating to air pollution.

OTHER LAWS:

The *Act* in no way limits the power of various public bodies, officials and private citizens to impose additional nonconflicting regulations on solid waste disposal in their own jurisdictions.

TRANSPORTATION OF GARBAGE ACROSS STATE & CERTAIN COUNTY BOUNDARIES:

Prohibited, except with permission of authorities in county where garbage will be dumped (See GEORGIA CODE, CHAPTER 23-32, as amended).

Potable Water

There will be a need for a source of potable water for the employees of an alumina-from-kaolin plant. In the event that such a plant is located in an area that cannot be serviced by a public or community water supply system, the company will have to provide its own water supply system.

An abstract of water supply quality control regulation is set forth below.

WATER SUPPLY QUALITY CONTROL

LEGAL REFERENCES:

For a detailed legal citation of the information summarized below, see:

- o GEORGIA CODE, CHAPTER 88-26. GEORGIA WATER SUPPLY QUALITY CONTROL ACT, as amended.
- o OFFICIAL COMPILATION RULES AND REGULATIONS OF THE STATE OF GEORGIA, CHAPTER 391-3-5.

CERTIFICATE OF APPROVAL:

- o A *Certificate of Approval* is required to operate a public or community water supply system.
- o The granting of the *Certificate of Approval* is based on whether the particular water supply system meets specified requirements and has the capability of providing a sufficient quantity of water meeting standards governing the quality of such water set forth in the RULES AND REGULATIONS.
- o Once granted, the Certificate will indicate the operating conditions that must be followed.

CONSTRUCTION OF THE WATER SUPPLY SYSTEM:

Before an industry is permitted to construct its water supply system, it must submit to and have approved by the Environmental Protection Division:

Engineering report prepared by a professional engineer containing a comprehensive description of the feasibility of the proposed project. A list of certain items that must be included in the report can be found in the RULES AND REGULATIONS.

Plans and Specifications prepared by a professional engineer that should include, but are not limited to, areas to be served by the water system, source and the treatment facilities of the system, and plant laboratory equipment necessary to make all analyses for the control of the processes involved.

General Plan Map that indicates the location of various structures, the size and type of the materials of the existing and proposed water mains, and other items enumerated in the RULES AND REGULATIONS.

WATER SUPPLY CLASSIFICATIONS:

In some instances varying requirements are set forth in the RULES AND REGULATIONS applying to these three classes:

Class I. Water supply systems supplying finished water from any surface water sources.

Class II. Water supply systems supplying finished water from ground water sources to more than 25 housing or mobile units, to schools, to State owned facilities, and to industrial operations employing more than 100 persons.

Class III. All other water supply systems supplying finished water from ground water sources, including but not limited to, tourist accommodations, food service establishments, and commercial establishments.

SOURCE OF WATER SUPPLY:

- o Industries must collect raw water samples for bacteriological examination before approval can be obtained for a source of water supply.
- o Standards for surface and ground water sources are found in the RULES AND REGULATIONS.

WATER TREATMENT FACILITIES:

Specific standards exist for:

Design and operation of surface and ground water treatment plants

Raw water and multi-level intakes

Raw water lines

Chemical feed equipment

Initial mixing

Flocculation

Sedimentation

Filtration

Use of finished water

Chlorination

Fluoridation

WELLS:

Specific standards exist for:

Distance between a well and a septic tank

Protection of pumping equipment and water treatment facilities

Construction of the well and maintenance of construction data

Turbine and submersible pump installation

Well casing

Location of the raw water sampling tap and the blow-off pipe

Rehabilitation of existing wells

Plugging and sealing of drilled holes

Furnishing of samples of raw water for bacteriological examination

Furnishing of the results of physical and chemical analysis of the raw water

SPRINGS:	Specific standards exist for: Construction and operation of springs Furnishing of samples of the raw water for bacteriological examination Furnishing the results of physical and chemical analysis on the untreated water
STORAGE TANKS AND DISTRIBUTION SYSTEM:	Specific standards exist for their construction and operation
DISINFECTION:	Specific disinfection standards exist for: All newly constructed water supply systems Storage tanks Water mains Wells
OPERATION OF THE WATER SUPPLY SYSTEM:	Specific standards exist for: Chlorination of the system Experienced operator on duty

Maintenance of a chemical and biological laboratory

Performance of bacteriological and chemical tests

Collection of samples for bacteriological tests

WATER SAMPLES: Specific standards exist for:

Number and places where samples must be taken

Shipment of samples

OPERATING RECORDS: Specific standards exist for the maintenance of operating records.

DRINKING WATER STANDARDS: Specific standards exist for:

Bacteriological quality

Physical characteristics

Chemical characteristics

Presence of radioactive materials

INSPECTIONS AND INVESTIGATIONS: EPD has the power to enter at reasonable times any private or public property for the purpose of inspecting or investigating conditions relating to the furnishing of water to the public.

ENFORCEMENT OF LAWS AND REGULATIONS

Enforcement actions are directed toward non-compliance with the applicable laws and regulations and pertain essentially to operating companies. An alumina-from-kaolin industry would be a new industry with new technologies and as such could not obtain permits without compliance.

Of the six types of environmental controls where enforcement is specified, all actions are similar in kind and severity with the exception of Water Quality Control. The five which are similar specify four types of action which may be taken by EPD.

Those actions are abstracted below.

ADMINISTRATIVE ORDER:

- When there is reason to believe that there has been a violation, the Environmental Protection Division (EPD) will first try to settle the controversy by conference, conciliation, and persuasion. If this fails, EPD has the authority to issue an administrative order, stating the necessary corrective action to be taken.
- A hearing before EPD's Administrative Review Officer may be requested no later than 30 days after such order is issued.

INJUNCTION: When there is reason to believe that any company has violated or is about to violate any provision of the *Act*, EPD may apply for an injunction to enjoin such violation.

MISDEMEANOR: Any industry that violates any provision of the *Act* or any rule or regulation, or fails, neglects or refuses to comply with any final administrative order will be found guilty of a misdemeanor and be punished by a fine not to exceed $1,000 or by imprisonment for no more than one year, or both.

CIVIL PENALTY: Any industry that violates any provision of the *Act*, or negligently or intentionally fails or refuses to comply with a final administrative order is liable to a civil penalty not to exceed $1,000 for such violation and an additional civil penalty not to exceed $500 for each day during which said violation continues.

The Water Quality Control enforcement has more severe fines than above and also includes a provision for Civil Liability.

Enforcement regulations are contained in the appropriate Georgia Codes as listed below.

Environmental Control	Georgia Code Chapter
Land Reclamation	43-4
Ground Water Control	17-11
Air Quality Control	88-9
Water Quality Control	17-5
Solid Waste Control	43-16
Potable Water	88-26

A-1458

ALUMINA from KAOLIN II

Industrial Development Division

ENGINEERING EXPERIMENT STATION

Georgia Institute Of Technology

Project A-1458

ALUMINA FROM KAOLIN - II

Prepared for
Georgia Department of Industry and Trade
Under a Grant From
The Coastal Plains Regional Commission

by
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Industrial Development Division
ENGINEERING EXPERIMENT STATION
Georgia Institute of Technology
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Summary

Because of inadequate domestic reserves of bauxite, an increasing interest has developed in the United States in recent years in alternate sources of raw materials for the production of aluminum. Dependence on developing nations for a supply of bauxite presents particularly difficult logistical problems during periods of emergency, and a growing nationalism plus the formation of a cartel of bauxite-producing countries have led to greater control by foreign sources of bauxite and alumina production and prices.

Of the other sources of aluminum, kaolin clay is perhaps the most promising. Until recent years, little had been done to investigate systematically the feasibility of extracting alumina from kaolin, and kaolin clays in sufficient amounts in contiguous bodies had not been identified.

Following the discovery in Georgia of a new body of kaolin estimated at from three to five billion tons, work by the National Materials Advisory Board and by the Georgia Institute of Technology, in cooperation with the Georgia Department of Industry and Trade, established the economic and technological feasibility of producing alumina from kaolin. The U. S. Bureau of Mines began a program of mini-piloting in 1973 to evaluate the various alumina-from-kaolin processes. During the past three years, technical work in the field has reduced the thermal energy consumption of an alumina-from-kaolin facility by 50% or more. Private companies have tested both standard and innovative alumina-from-kaolin processes, and pilot plants of up to 20 tons per day have been in operation and larger pilot plants are planned.

Based on an assumption of optimum technology, the same thermal energy requirements for each process, an output of 1 million short tons per year, and $600 million in capital investment, the cost per net short ton of alumina has been estimated for the three most promising alumina-from-kaolin processes as follows:

Hydrochloric acid process	-	$137.89
H+ (Pechiney/Alcan) process	-	139.81
Nitric acid process	-	142.35

If it is assumed that the thermal energy requirements of the hydrochloric acid process could be reduced from 25 million Btu to 18 million Btu, as some

evidence indicates, the estimated cost per net short ton of alumina for this process would be reduced from $137.89 to $129.77. If it is assumed that a nitric acid process plant would cost 25% less than a hydrochloric plant because of less corrosion, as some evidence indicates, the estimated cost per net short ton of alumina for this process would drop from $142.35 to $125.85. On the other hand, if it is assumed that the nitric acid process would require 50% more energy because of greater water of hydration, as it perhaps would, the estimated cost would increase to $155.40 under the unadjusted capital investment assumption.

The future of an alumina-aluminum industry in Georgia is related to energy policies and developments. While considerable energy is required to produce aluminum, once produced the metal is lightweight and will save enormous amounts of energy, particularly in the transportation and construction industries. If energy rates were to be equalized throughout the country as federal energy policies propose, Georgia's position as a location for an integrated aluminum industry would be enhanced. Foreign suppliers of alumina would have to compete with a domestic ore source that is close to present refineries and is a potential location, on an equalized energy basis, for new reduction facilities. The primary advantages would be greatly reduced transportation costs, the ability to use coal in processing, savings in process energy through integration of facilities, closeness to the market, and elimination of the problem of disruption by international crises.

It is projected that the first alumina-from-kaolin facilities will be established in Georgia between 1980 and 1985, that these facilities will achieve an output of one million tons annually between 1988 and 1993, that an aluminum reduction facility will be established between 1990 and 1995, and that a vertically integrated aluminum co-sited complex will be established in Georgia between 1993 and 2000.

With the possibility in mind of the start-up in Georgia of an alumina-from-kaolin facility on a commercial basis as early as the first half of the 1980 decade, the following four potential site areas are identified, based on the availability of a sufficient quantity of an appropriate quality of kaolin, the availability of adequate water to operate an alumina-from-kaolin process, the presence of transportation facilities, and a consideration of the impact of the plant on the environment of the area:

1. Wrens area -- portions of Jefferson, Glascock, and Warren counties and possibly some of McDuffie County.

2. Sandersville area -- all of Washington County

3. McIntyre area -- portions of Twiggs and Wilkinson counties and possibly some of Baldwin County.

4. Andersonville area -- portions of Sumter and Schley counties.

INTRODUCTION AND BACKGROUND

Objectives of Report

There are three objectives of this report. The first is to update information on the technology and economics of securing alumina from kaolin. The second objective is to present a timetable showing the near-future potential of an alumina-from-kaolin facility in Georgia. Based on the imminent potential of such a facility, the third objective is to identify potential sites for consideration in terms of the various parameters that may be used by industries for their choice in the location of alumina-from-kaolin plants. The timetable for the development of Georgia's aluminum industry is introduced in this initial section and completed in the following section. The two other objectives are the subjects of separate major sections of this report.

Background and Review

Bauxite has been the ore of aluminum used throughout the world since shortly after the invention of the Bayer process in 1888. Bauxite is found in great abundance in the world, with reserves of bauxite measured in billions of tons, possibly on an order of ten or more billions of tons on a worldwide basis. The process for extracting alumina from bauxite is well known and the economics are reasonably good. The problem of using bauxite as the ore of aluminum, however, is that most industralized nations do not have reserves of bauxite. Hence, they are dependent on developing nations, primarily in tropical or semi-tropical areas, for their bauxite supply. With the exception of Australia, countries where bauxite is produced have been principally suppliers of either bauxite or alumina produced by the Bayer process and not markets for aluminum. In time of war the strategic logistics of moving bauxite or alumina from the source areas to an industralized nation have been quite severe. The future problems are likely to be even more complex. In the last few years, bauxite-producing countries have formed a cartel to raise the price of bauxite. There also has been a growing nationalism and with it a tendency for the countries where bauxite is found to exercise more and more control over bauxite and alumina production.

As a result of these developments, industrialized nations have looked more and more for sources of aluminum other than bauxite. Of the other sources of aluminum, kaolin clay, which is principally composed of the mineral kaolinite, is perhaps the most promising. Pure kaolinite contains 39+% alumina (Al_2O_3), with the remainder being water of hydration and silica. Chemically, it is a very simple mineral. It is not a multicomponent system but only a binary system in terms of extracting the alumina. After calcining, alumina is easily extracted by acid with the silica being left as a solid.

Work on nonbauxite sources of aluminum in the United States began during World War II when alumina suppliers were critically affected by submarine warfare. The search was for a domestic source of aluminum in sufficient quantities to supply the United States. The Arkansas bauxites have been the single domestic source of bauxite for the aluminum industry, and this has never been adequate for any long-term consideration as a source of aluminum for the United States.

The problem which has plagued the efforts to use a clay, particularly a kaolinite or kaolin clay, for aluminum has been one of economics and, to some degree, technology. Technologies have been known that could utilize clay as a source of aluminum. All of the technologies used in the past for kaolin were energy intensive and could not compete with the economics developed for the Bayer-bauxite process which also used a higher grade ore. There was a further problem that clays in sufficient amounts in contiguous bodies were not known. Scattered lenses were identified, but large contiguous bodies were not known prior to about 1963.

As an example, a study was made by Georgia Tech in 1958-59 concerning the reserves of kaolin in the state of Georgia. A best estimate was on an order of magnitude of 500 million tons. In the early 1960's a new body of kaolin was discovered in what is now known as the Wrens district in the northeast area of the Fall Line of Georgia. Clays in this area were estimated to be on an order of magnitude of three to five billion tons, depending on the depth of mining which would be anticipated. This obviously greatly changed the outlook for the use of clay for aluminum, but knowledge of these reserves was kept relatively secret by the various kaolin companies in order that they might secure the best reserves for their own operations for conventional uses of kaolin.

As a result of this knowledge, the Georgia Department of Industry and Trade and Georgia Tech in 1970 jointly sponsored a conference between the primary aluminum producers, kaolin producers, and various representatives of both federal and state governments. Probably the most significant result of this meeting was that the primary aluminum companies became aware of the enormous reserves in Georgia of clay suitable for the production of alumina. In December 1970, the National Materials Advisory Board issued publication NMAB-278, which was entitled *Processes for Extracting Alumina from Nonbauxite Ores*. To quote directly from the summary of conclusions and recommendations: "An acid process for the treatment of clay appears the most promising for the economic production of alumina from materials other than commercial bauxite." Shortly afterward, the Georgia Department of Industry and Trade began a series of contracts with the Georgia Institute of Technology involving an investigation of the potential and the possibility of obtaining alumina from clay. This study and subsequent studies were underwritten by the Coastal Plains Regional Commission.

As a result of the first contract, a report entitled *Alumina from Kaolin Potentials* was issued in April 1972. The 1972 report was primarily a feasibility report that established the economic and technological feasibility of producing alumina from kaolin. The advantage of the report was that it showed that calcination of kaolin followed by acid extraction and solvent extraction of the impurities would produce an alumina within an economic range of the produced cost by a Bayer-bauxite process. The cost that was estimated in 1972 was some $12 higher for kaolin than for bauxite (the estimated cost of alumina from bauxite was $48 versus $60 for alumina from kaolin). The closeness of the price of alumina from kaolin versus that of alumina from bauxite by the Bayer process aroused the interest of both government and industry.

Another part of the 1972 report was a recommendation that the U. S. Bureau of Mines choose and pilot an alumina-from-kaolin method. In the previously mentioned NMAB Report 278 it was also recommended that the Bureau of Mines do piloting on a best method. As a result of these recommendations, the U. S. Bureau of Mines, effective July 1, 1973, began a program of mini-piloting, starting with a nitric acid process for the extraction of alumina from kaolin. The mini-piloting program of the U. S. Bureau of Mines was conducted in cooperation with various members of the extractive alumina industry. Initially, the group had approximately eight companies involved and, at last count, ten companies were involved in the cooperative effort with the government.

The nitric acid mini-piloting has been completed and hydrochloric acid methods are in progress. The hydrochloric acid methods are essentially the same for calcination and extraction of alumina from kaolin. The crystallization method may vary, as both hydrogen chloride sparging and evaporation have been considered. Other ideas are being tried, such as different final calcination methods, hence the experimental mini-piloting using hydrochloric acid as an extractive agent is still in progress.

It is of considerable significance that there has been a steady reduction in the amount of energy believed to be necessary to produce alumina from kaolin. In 1974, Georgia Tech, under the same sponsorship mentioned previously, issued a report entitled *Alumina from Kaolin*. This report updated work from *Alumina from Kaolin Potentials* and also gave comparative costs between estimates made in U. S. Bureau of Mines I.C. 8648 and more recent information available in 1974 concerning thermal energy and mining costs. This publication showed roughly 36-37 million Btu for a hydrochloric acid process and an order of magnitude of 49 million Btu for a nitric acid process. Today a hydrochloric acid process is variously estimated at between 17 and 25 million Btu instead of 36 million, and a nitric acid process has been estimated at under 25 million Btu instead of 49 million. In other words, in a period of roughly three years, technical work has been able to lower the thermal energy consumption per short ton of an alumina-from-kaolin facility by 50% or more.

In the 1972 report, indications were that a nitric acid process probably would be feasible and preferred. By 1974, it became obvious that the nitric acid method might not be the preferred method, because nitric acid is obtained from ammonia and ammonia is made from natural gas. Hence, the supply of nitric acid for an alumina-from-kaolin facility would be in direct competition for natural gas, hydrogen, and, more importantly, for ammonia and ammonia products for the agricultural industry. Also by 1974 it became clear that some of the difficulties initially encountered in a hydrochloric acid process, namely the removal of iron, could be conquered technically and economically, so that today it appears that a hydrochloric acid process could be the one preferred among those being tested by the U. S. Bureau of Mines.

In addition to the various processes being considered by the U. S. Bureau of Mines, the French company, Pechiney Ugine Kuhlmann, in an equal partnership with the Aluminum Company of Canada (Alcan), has been testing and is piloting an alumina-from-kaolin process known as the H+ process. This process uses concentrate 95% sulfuric acid to extract the alumina from kaolin and subsequently uses hydrogen chloride to produce aluminum chloride hexahydrate, which is the same intermediate product produced in the hydrochloric acid process. This process must have appeared feasible both technically and economically, because Pechiney-Alcan mini-piloted the H+ process and then built a 15-20 metric ton per day pilot plant which they started operating at the end of the summer of 1976. Confidence in such a large pilot plant would indicate a good deal of technical and economic success. The process, however, is proprietary and little is known except what is given in the literature.

The Anaconda Company, now a division of Atlantic Richfield Corporation, piloted a hydrochloric acid extraction method in the mid-1960's on a 5-7 ton-a-day basis for an 18-month period. Alumina obtained in this pilot was reduced at the company's Great Falls production plant and aluminum metal was made. This indicates, therefore, that a hydrochloric acid method was feasible technically.

The U. S. Bureau of Mines has a contract with Kaiser Engineers, which has subcontracted to Kaiser Aluminum and Chemical Corporation to make a feasibility study to select the best of two methods for a nonbauxite source of aluminum and, from this, to come up with the best method for a large pilot plant (10-50 tons per day).

Project Timing of Commercial Development

The preceding review leads to a consideration of the possibility of a near-term start-up of an alumina-from-kaolin facility on a commercial basis. The following timetable is based on the proposed timing of the U. S. Bureau of Mines contract work and is considered to be maximum, since timing is on a risk elimination basis:

Stage	Stage Time	Completion Dates
Feasibility study	27 months	Jan. 1979
Design and build demonstration pilot	30 months	July 1981
Operate demonstration pilot	18 months	Jan. 1983
Refine process costs	6 months	July 1983
Design and build commercial plant	42 months	Jan. 1987

Through an acceleration of the initial phasing and a reduction of stage times, it is not unreasonable to project a 1984 start-up date for a commercial plant. The accelerated timetable follows:

Stage	Stage Time	Completion Dates
Feasibility study	12 months	Oct. 1977
Design and build demonstration pilot	24 months	Oct. 1979
Operate demonstration pilot	12 months	Oct. 1980
Refine process costs	6 months	April 1981
Design and build commercial plant	24 months	Oct. 1984

If time estimates are correct and news releases are accurate, it can be assumed that the H+ process is already in operation on a demonstration pilot and that this venture is ahead by some three years of the estimated time for completion of a commercial plant. Based on this assumption and splitting the difference between risk eliminating and accelerated approaches, this would give approximately 1982 for a first commercial plant of alumina from clay. Since the H+ process is being developed in France, it is not possible, of course, to know whether or not it would be used in this country.

As previously mentioned, the Anaconda Company successfully piloted an alumina-from-Georgia-kaolin facility in Montana over 12 years ago. Aluminum metal was produced from the alumina product. Allowing for some slippage and updating of this work, late 1980 could be a good early time for a commercial alumina facility, by use of this research. Anaconda's work was and is proprietary, so any such considerations must remain speculative.

UPDATED ALUMINA-FROM-KAOLIN TECHNOLOGY AND ECONOMICS

Alumina-from-Kaolin Processes

Kaolinite is the mineral source of alumina in kaolin clays. Kaolinite is a hydrous aluminum silicate [$Al_4Si_4O_{10}(OH_8)$]. In order to obtain the alumina from this mineral it is necessary to break the bond between the silica and the alumina. This may be accomplished in either of two ways. The favored way is to heat it to around $600^{\circ} \pm 50^{\circ}$C., which not only breaks the bond between the silica and alumina, but also drives off all water of crystallization. The other method uses sulfuric acid of 95% strength at elevated temperatures to break the bond.

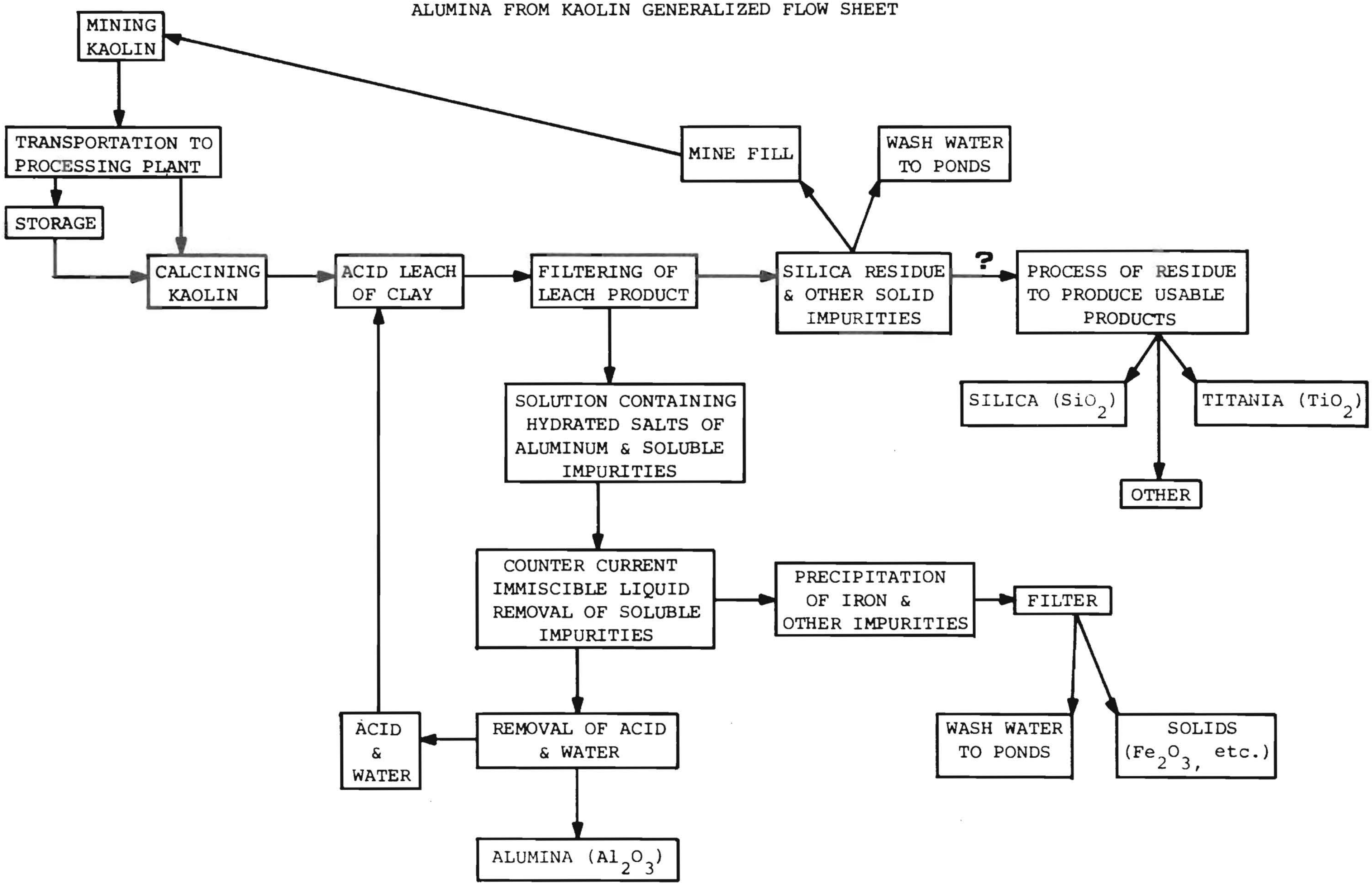
Once the bond is broken, there are several ways to obtain the alumina from the ore. Again, the method generally preferred is to use an acid and extract the alumina into solution. Chlorine gas at elevated temperatures has also been used to obtain the alumina from kaolin. Only one company is proposing the use of chlorine gas to obtain alumina from kaolin clays. There are several methods and several acids proposed to extract alumina by an acid-aqueous solution.

Figure 1 shows a generalized flow sheet for an acid extraction method. The acids considered are hydrochloric, nitric, sulfuric, and sulfurous. With the possible exception of the H+ process, all require calcination of the kaolin to break the silica-alumina bond. The H+ process reportedly can break the silica-alumina bond with 95% sulfuric acid without calcination.

Each process digests kaolin in acid, filters the silica and other solid impurities, removes soluble impurities from the filtrate, and precipitates and then calcines a hydrous aluminum salt to recover water and acid to produce a 99.9+% pure alumina. Obviously, there are some differences, but each method is considered to be technically feasible. The question is whether or not any or all methods are economically competitive (in both the short and long term) with the Bayer-bauxite method of producing alumina. Other questions may be related to the relative merits of the above methods when compared with each other and with Bayer-bauxite extraction regarding environmental problems, energy, and operating and construction materials. A sulfurous method or process has not generated as much interest or research as the other three acids.

Figure 1

ALUMINA FROM KAOLIN GENERALIZED FLOW SHEET



It is reasonable to speculate that sulfurous acid may not be as advantageous as any one of the other methods, but definitive answers are not at hand and must be developed before judgment can be made. It should be noted, however, that there is no apparent interest by industry in this particular method, but it was included in potential methods in early government studies.

The three acids in which there appears to be the most interest as extractive agents for alumina from kaolin are hydrochloric acid, nitric acid, and sulfuric acid. There are variations in the use of each acid. The H+ process uses both sulfuric acid and hydrochloric acid; the sulfuric acid is used to extract the alumina, and hydrogen chloride is used to precipitate a pure aluminum chloride hexahydrate for calcination to reduction-grade alumina. A brief description of three acid processes that appear to have current industrial interest are given with estimates of cost for alumina. Each estimate has notes explaining the derivations of the data. Each also is considered to be based on the optimum technology under consideration.

Hydrochloric Acid Process. The use of hydrochloric acid to extract alumina from kaolin is currently under investigation in the mini-pilot plant of the U. S. Bureau of Mines in Boulder City, Nevada. The various differences in technology are being tested, as well as materials of construction, energy consumption, and the overall efficiency of each method.

In early considerations there appeared to be three problems with the use of hydrochloric acid. The first problem, which is believed to have been conquered, was that it extracts iron much more efficiently than the other acids under consideration. A method of removing iron from the solution has been successfully accomplished and this is no longer considered a problem. The second problem is the total removal of hydrogen chloride (in final calcination). Vestiges of hydrogen chloride tend to remain, and it takes direct high temperature to finally remove all of the HCl. Methods of overcoming this difficulty are being explored, and it is not considered an insoluble problem. The third difficulty is that hydrochloric acid and hydrogen chloride are very corrosive; this causes a problem in materials of construction. This is another one of the problems which is being dealt with and explored in the U. S. Bureau of Mines mini-pilot. Since Anaconda dealt successfully with this problem, it is considered to be manageable.

One consumer of energy has been the crystallization of aluminum chloride hexahydrate from solution. Evaporation was first used to concentrate the solution and, hence, to cause the crystallization of aluminum chloride hexahydrate. A recent innovative approach is to sparge the solution containing alumina with hydrogen chloride in order to chemically drive the reaction toward crystallization without the enormous amount of energy used in the evaporative process. The estimated costs which follow are based on energy consumption using sparging with hydrogen chloride instead of evaporation for crystallization of $AlCl_3 \cdot 6H_2O$.

The calcination to alumina of aluminum chloride hexahydrate in a hydrochloric acid process is the same as will be found in the H+ process, which obtains the alumina from a sulfuric acid solution by the use of hydrogen chloride. The energy, therefore, for calcination of the hydrous salt to the oxide and the problems of freeing the salt and the final oxide of all hydrogen chloride are the same for both the hydrogen chloride process and the H+ process. When compared with the nitric acid process, there are six waters of hydration for aluminum chloride as compared with nine waters of hydration for aluminum nitrate. In other words, there is 50% more water of hydration in $Al(NO_3)_3 \cdot 9H_2O$ than in $AlCl_3 \cdot 6H_2O$ and, hence, that much greater energy will be required for calcination of the hydrous salt of the nitrate as compared with that for the chloride.

In the cost estimates, it should be noted that 25 million Btu is the total thermal energy used for each of the three processes under consideration. This was done to give a standard basis of comparison, since the final energy in each of these processes has not been determined by large-scale piloting. It should also be noted in the cost figures for the hydrochloric acid and the notes related to energy that there is speculation that the oxide of aluminum as obtained by the hydrochloric acid process may require only 18 million Btu instead of 25 million Btu. On the other hand, if the 25 million Btu is correct for the hydrochloric acid process, then it is possible that the nitric acid process would require up to 37.5 million Btu. This is the right comparative order of magnitude if consideration is given to the amounts of water of hydration between the hydrochloric and nitric acid methods.

Table 1, as well as the succeeding tables in this section, present estimates on a cost per ton of Al_2O_3 based on one million short tons of production per year and an estimated $600 million of capital investment. As noted, these

Table 1

ESTIMATE OF UNIT COSTS OF Al_2O_3 BY THE HCl PROCESS(1)

Item	Unit	$ Unit	Units Used	$ Per Net Short Ton Al_2O_3
Raw Materials				
Clay, mining, reclamation, transportation to plant	Short ton	5.00(2)	3.3	16.50
Solid residue back to mine	Short ton	1.00	2.0	2.00
HCl, 22° Be	Short ton	73.40(3)	0.05	3.67
H_2SO_4, 95%	Short ton	43.70(4)	0.05	2.19
Solvents (5)	Total Combined			1.50
Subtotal				25.86
Utilities				
Electric Power	KWH	0.02(6)	250	5.00
Process Water	10^3 gal.	0.10(2)	1.5	.15
Raw Water	10^3 gal.	0.02(2)	1.0	.02
Coal	10^6 Btu	1.16(7)	22.5(9)	26.10
Oil (Low S, No. 2)	10^6 Btu	2.57(8)	2.5(9)	6.43
Subtotal				37.70
Labor				
(Exclusive of maintenance including all benefits)				
Plant	Hour	10.00	0.333	3.33
Staff and supervision	Hour	15.00	0.333	5.00
Subtotal				8.33
Plant Maintenance				
(Including labor and materials)	4% C.I.			24.00
Fixed Costs				
Taxes, insurance, and contingency	2% C.I.			12.00
Depreciation	5% C.I.			30.00
Subtotal				42.00
TOTAL				137.89(9)

TABLE 1: Notes on HCl Process Costs

(1) Output of 1 million short tons per year and $600 million capital investment. Capital investment costs based on various inflation factors as compared with 1974 estimates.

(2) Current area estimate. Cost of clay includes dry mining with large equipment and dry haulage to plant plus labor benefits.

(3) Current estimate for food grade 22^{o} Be HCl delivered to Augusta, Georgia, from Louisiana.

(4) Current estimate for 95% H_2SO_4 delivered to Augusta, Georgia, from Copper Hill, Tennessee.

(5) Includes amines, alchohols, and kerosene as a carrier.

(6) Current estimate from the Georgia Power Company.

(7) Based on estimate from Southern Railway System.

(8) Price estimated from Oil and Gas Journal prices. Units used based on 140,000 Btu per gallon.

(9) Thermal energy of 25,000,000 Btu was used for all three acid processes in table proper. It is speculated that this can be reduced to 18,000,000 Btu for the hydrochloric acid process, with resulting reduction in total cost per net short ton of Al_2O_3 to $129.77 (assuming reduction to 15,500,000 Btu from coal).

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are April 1977 estimates. The estimates for the hydrochloric acid method were first made in February 1977, but the costs are not believed to have changed since that time, and this will permit all estimates to be on the same time basis.

The H+ Process. The H+ process is a patented process with patents held by Pechiney Ugine Kuhlmann of France and the Aluminum Company of Canada (Alcan). Information concerning this process has been obtained from various sources, including press releases, papers at scientific meetings, and patents. Details of the process are proprietary and have not been released. It is known, however, that a mini-pilot has been used for several years, and a larger pilot capable of producing 15 to 20 metric tons of alumina per day went on stream in early fall of 1976. The confidence in the process as exhibited by the large pilot plant would indicate that many of the problems that could be envisioned have been overcome.

The H+ process differs from the other acid processes in that it uses two acids. The initial digestion of a kaolin clay is in a concentrated (95%) sulfuric acid. Sulfuric acid of this strength will extract alumina from kaolin without prior calcination, but after drying. Pechiney-Alcan has not made known if the same high percentage of extraction can be obtained by a concentrate sulfuric acid without calcination of kaolin as can be obtained with calcination preceding the extraction. If the kaolin does not have to be calcined for the H+ process, a substantial amount of energy would be saved. In a sulfuric acid attack of kaolin, the solution would contain, in addition to the aluminum sulfate, relatively large amounts of silica, some iron, and possibly small amounts of titanium. The oxides of titanium, rutile, anatase, and brookite (the mineral species normally found in kaolin) do not dissolve in acid, but the solid solution iron impurities in the weathered condition could yield traces of titanium. The alkali metals would probably precipitate as sulfates. The acid solution, following the extraction of alumina from kaolin and subsequent filtration, is diluted and sparged with hydrogen chloride to precipitate a relatively pure aluminum chloride hexahydrate. The aluminum chloride hexadydrate is filtered or separated from the liquid and calcined to aluminum oxide, the same as in the hydrochloric acid method. Both the sulfuric acid and the hydrochloric acid are recovered for reuse.

The cost estimates in Table 2 have followed the same procedure as in estimating the other acid methods. It should give a basis of comparison of cost, and the estimate itself is expected to be a reasonable approximation of true cost.

Whether or not the H+ process will be used in the United States is not known; however, if the process being developed in France is successful, it is hoped that the technology will be made available for use in the United States on Georgia clays.

Nitric Acid Process. A nitric acid process has been piloted by the U. S. Bureau of Mines in its mini-plant at Boulder City, Nevada. The results of this piloting and calculations derived from it are still being studied, so that no final report of this process has been issued. The 1972 report by Georgia Tech

Table 2

ESTIMATE OF UNIT COSTS OF Al_2O_3 BY THE H+ PROCESS(1)

Item	Unit	$ Unit	Units Used	$ Per Net Short Ton Al_2O_3
Raw Materials				
Clay	Short ton	5.00(2)	3.3	16.50
Solid residue back to mine	Short ton	1.00	2.0	2.00
HCl, 22° Be	Short ton	73.40(3)	0.03	2.20
H_2SO_4, 95%	Short ton	43.70(4)	0.10	4.37
Solvents (5)	Total Combined			1.50
Subtotal				26.57
Utilities				
Electric power	KWH	0.02(6)	300	6.00
Process water	10^3 gal.	0.10(2)	2.6	.26
Raw water, cooling	10^3 gal.	0.02(2)	6.0	.12
Coal	10^6 Btu	1.16(7)	22.5	26.10
Oil (Low S, No. 2)	10^6 Btu	2.57(8)	2.5	6.43
Subtotal				38.91
Labor				
(Includes all benefits)				
Plant	Hour	10.00	0.333	3.33
Staff and supervision	Hour	15.00	0.333	5.00
Subtotal				8.33
Plant Maintenance				
(Including labor and materials)	4% C.I.			24.00
Fixed Costs				
Taxes, insurance, and contingency	2% C.I.			12.00
Depreciation	5% C.I.			30.00
Subtotal				42.00
TOTAL				139.81

TABLE 2: Notes on H+ Process Costs

(1) Output of 1 million short tons per year and a capital investment of $600 million were used to establish a basis for comparison with other acid methods.

(2) Current area estimate. Cost of clay includes mining, reclamation, dry haulage to plant, and all mining labor benefits.

(3) Current estimate for food grade 22^{o} Be HCl delivered to Augusta, Georgia, from Louisiana.

(4) Current estimate for 95% H_2SO_4 delivered to Augusta, Georgia, from Copper Hill, Tennessee.

(5) Includes amines, alchohols, and kerosene as a carrier.

(6) Current estimate for the Georgia Power Company.

(7) Based on estimate from Southern Railway System.

(8) Price estimated from Oil and Gas Journal prices. Units used based on 140,000 Btu per gallon.

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entitled *Alumina from Kaolin Potentials* used a nitric acid process to establish the feasibility of obtaining alumina from kaolin. At that time, this was a favored process. Since then, however, with more information on the hydrochloric acid process and the uncertainty of obtaining ammonia, the nitric acid process has not been looked upon with as much favor as it was; however, nitric acid extraction still may be a very valid process. Since ammonia may be obtained from coal and some companies are converting to coal preparation of ammonia, the problem of obtaining ammonia may not be as great as once feared. Various gasification methods of treating coal yield an ammonia product among others.

The report EPA-600/7-76-034h, December 1976, on EPA Contract 68-03-2198 entitled *Environmental Consideration of Selected Energy Conserving Manufacturing Process Options, Volume VIII, Alumina/Aluminum Industry Report* stated on page 83 that "nitrates are suspected of being carcinogenic." This too would pose a problem in the use of nitrates and the disposal of waste products derived from a nitrate treatment plant.

The cost estimates that are given in Table 3, as indicated in the notes which follow, are based on some updating of the 1974 estimates in the *Alumina from Kaolin* report issued by Georgia Tech in November 1974. In the current estimate, $600 million is used for capital investment cost. Some believe that a nitric acid plant probably can be built for 25% less than a hydrochloric acid plant because of less corrosion, but others speculate that capital investment could be higher because of the additional cost to reconstitute multiple oxides of nitrogen. Until such time as piloting or other evaluation work has been accomplished this is not known. Hence, capital investment was calculated on the same basis as a hydrochloric acid plant. There is no question, however, that more energy would be required in a nitric acid process because of a 50% greater water of hydration in the aluminum salt.

Overall Process Considerations. In any consideration of methods of obtaining alumina from kaolin at this time, it must be remembered that none of the processes have been used in commercial production of alumina. Further, only the hydrochloric acid method has been tested with a fairly substantial pilot plant. This was the Anaconda plant which tested for a period of approximately 18 months, producing between five and seven tons per day. This work, however, was done in the mid-1960's; since that time, new construction materials and technology have become available and need to be tested and evaluated before any commercial plant is put into production.

The H+ process has been mini-piloted and has had a 15-20 metric-ton pilot in operation from late summer 1976 to the present writing. A pilot of this size should give substantial information to be upgraded to a commercial plant. When this work will be completed is not known and information is proprietary.

The nitric acid process has been tested in a mini-pilot plant operated by the U. S. Bureau of Mines at Boulder City, Nevada, and, reportedly, there has been some industry piloting. Industry work, however, is proprietary and no information is available.

Because of the lack of large-scale piloting in most instances, the time frame, and the proprietary nature of work by industry, the above cost estimates must of necessity be speculative. However, the costs are believed to be good "ball park" figures and useable as a basis of comparison. It should be pointed out that the differences in cost per ton may change if and when commercial plants are built.

Table 3

ESTIMATE OF UNIT COSTS OF Al_2O_3 BY HNO_3 PROCESS(1)

Item	Unit	$ Unit	Units Used	$ Per Net Short Ton Al_2O_3
Raw Materials				
Clay, mining, reclamation, transportation to plant	Short ton	5.00(2)	3.3	16.50
Solid residue back to mine	Short ton	1.00	2.0	2.00
NH_3 (for HNO_3)	Short ton	180.00(3)	0.05	9.00
HCl	Short ton	73.40(4)	0.018	1.32
Solvents (5)	Total Combined			1.50
Subtotal				30.32
Utilities				
Electric power	KWH	0.02(6)	250	5.00
Process water	10^3 gal.	0.10(2)	1.5	.15
Raw water	10^3 gal.	0.02(2)	1.0	.02
Coal	10^6 Btu	1.16(7)	22.5(9)	26.10
Oil (Low S, No. 2)	10^6 Btu	2.57(8)	2.5(9)	6.43
Subtotal				37.70
Labor				
(Includes all benefits)				
Plant	Hour	10.00	0.333	3.33
Staff and supervision	Hour	15.00	0.333	5.00
Subtotal				8.33
Plant Maintenance				
(Includes maintenance labor)	4% C.I.			24.00
Fixed Costs				
Taxes, insurance, and contingencies	2% C.I.			12.00
Depreciation	5% C.I.			30.00
Subtotal				42.00
TOTAL				142.35(9)

TABLE 3: Notes on HNO_3 Process Costs

(1) Output of 1 million short tons per year. Capital investment cost used is the same as for the hydrochloric acid process in order to give a standard comparison. It is speculated that a nitric acid process plant would cost 25% less than a hydrochloric acid plant. If true, this would lower the total unit price to $125.85 instead of $142.35 for this estimate, with other costs remaining the same.

(2) Current area estimate. Cost of clay includes mining with large equipment, reclamation, dry haulage to plant, and all labor benefits.

(3) Ammonia is used to make HNO_3 and would be the preferred method of shipment. Price of ammonia is estimated on a delivered basis to the Macon-Augusta area. The price of ammonia fluctuates with the agricultural market.

(4) Current estimate for food grade 22° Be HCl delivered to Augusta, Georgia, from Louisiana.

(5) Includes amines, alcohols, and kerosene as a carrier.

(6) Estimate from Georgia Power Company.

(7) Estimate from Southern Railway System.

(8) Price estimated from Oil and Gas Journal price listings. Units based on 140,000 Btu per gallon.

(9) If the energy requirement estimate for the HCl process is correct at 25 million Btu, then 50% more energy to drive off nine waters of hydration would raise the cost per ton by $13.05 (assuming energy increase is in coal) to a total of $155.40, if capital investment remains the same.

Environmental Considerations

In the previous Georgia Tech publication entitled *Alumina from Kaolin -- Environmental Considerations*, an item-by-item description was given where potential environmental problems could occur. In addition, an abstract of Georgia regulations and laws was given, as well as other environmental information.

There are two major areas where good environment practices must be observed: reclamation following mining and operations within the plant proper.

Georgia law prescribes neither the manner in which mining must take place nor the methods to be used in land reclamation. What it does require is an engineering report and detailed explanation of the end result of reclamation; until a company can satisfactorily show that it will meet the prescribed reclamation as required by law, it will not be permitted to mine. The reclamation of land in the kaolin area is not expected to be difficult. The kaolin companies that have mined in the area have established reclamation practices, and, in the case of mining kaolin for an alumina plant, the reclamation process should be made easier by the return of some two-thirds of the material mined in the form of a granulated silica product from the tailings. The pH of the tailings returned to the mines can be carefully controlled, and any acidity which has not been washed out can be neutralized with lime. The resultant soil should be excellent agricultural land and, under proper conditions could be better than the land before mined.

Environmental considerations for the plant proper relate to the quality of engineering and maintenance, which include the ability to maintain a closed system in the processing of the clay to obtain the alumina.

Air and water effluent are very carefully prescribed by Georgia law, and all plants must meet the requirements. Again, however, the alumina-from-kaolin facility will be a closed system in order to recover the acid and the water for recirculating in the process. As such, effluents would be essentially non-existent.

Future Potentials in Georgia

Any consideration of the future of an alumina-aluminum industry in Georgia must take into consideration the energy potential of the future. Energy from fossil fuels is energy from a nonrenewable resource, and any projections for the future of energy must take into account rising costs and dwindling amounts of energy. Planning cannot use a straight-line increase in energy consumption because the energy will not be available. However, the President's National Policy, which starts with conservation and planning, should permit the legitimate needs of industry to be met. Emphasis will be, of course, on saving energy wherever possible. In the case of aluminum the short-and long-term effects on total energy requirements will have to be considered. While considerable energy is required to produce aluminum, once produced the metal is lightweight and will save enormous amounts of energy, particularly in the transportation and construction industries. The trade-off here appears to be in favor of producing more aluminum metal. This conclusion is reinforced by the fact that a new process developed by Alcoa appears to be capable of reducing the energy used in making aluminum metal by at least one third.

The new energy program of the federal government appears to put major emphasis on reduction of energy both by manufacturing industries and by vehicles used in transportation. The major goal is to reduce the use of nonrenewable fuels, particularly petroleum fuels such as those used for automobiles and trucks. An obvious way to reduce fuel consumption is by reducing weight, and an obvious way of reducing weight is by the use of aluminum or other lightweight metals in the production of automobiles and trucks. Most other light metals are more costly than aluminum, and the technology and capacity of production is not as advanced.

Another goal of the federal energy policy is the equalization of energy rates throughout the United States. Such equalization should come about whether a matter of federal policy or not. The fossil and nuclear sources of energy should be the same cost for all, except for transportation, and hence the electrical energy which may be derived from such sources should be essentially the same. Federal policy could accelerate the equalization of prices in all states.

If energy costs were constant rather than variable, greater attention would have to be focused on the other variables that affect the cost of aluminum to the American consumer. A major factor is transportation. Since only a minor fraction of its needs can be met by domestic sources, the aluminum industry imports bauxite in large quantities. The movement of bauxite by ocean freight costs approximately the same as moving alumina by ocean freight. Since the alumina will contain on an average twice the aluminum as the bauxite ore, the pressure will be to make the alumina in the country of origin of the ore. In most areas of the world the energy used to produce alumina from bauxite is petroleum. By all projections the cost of petroleum is expected to accelerate upward. This will put an added cost on the production of alumina and, since most ocean transportation is also fueled by petroluem products, it would put an added cost on ocean transport.

Foreign suppliers of alumina, with the probable exception of Australia, are also faced with the possibilities of cutoff of supplies if there are embargos or other international actions that will affect the distribution of petroleum on a world market. This must then be compared with domestic ore source in the southeastern United States, namely Georgia, which is close to present refineries and is a potential location, on an equalized energy basis, for new reduction facilities. The advantages would be much less transportation and also the ability to use coal in the processing. It is expected that coal will be more readily available and also cheaper on a Btu basis than petroleum. The current price of coal is $1.16 a million Btu, compared with $2.57 a million Btu for #2 low sulfur grade petroluem product. This type of differential will probably expand.

If a reduction plant were to be put in Georgia when energy costs were essentially equal, there would be a further savings in process energy because the hot aluminum metal, with little or no loss of heat, could be transferred directly to fabrication or casting facilities. Being a part of the United States market located in the Southeast, it should enjoy a much lower cost of aluminum on a delivered basis within the continental United States. Further, the problem of disruption by international crises would be eliminated since raw materials would not have to move by ocean freight.

The outlook is promising that an integraded aluminum industry will be located in Georgia sometime in the future. Projected timing for such a development is extremely difficult and, at best, tentative. Based on the accelerated timetable outlined earlier in this report for the development of a commercial alumina-from-kaolin facility, the following is considered to be a reasonable timetable for an integrated aluminum industry in Georgia:

		Year
First alumina-from-kaolin facilities	Between	1980 - 1985
One million annual tons of alumina facilities	"	1988 - 1993
Aluminum reduction facility	"	1990 - 1995
Vertically integrated aluminum co-sited complex	"	1993 - 2000

While this timetable is thought to be realistic, it could be accelerated by national policy or by international events. It is not expected to be greatly delayed.

POTENTIAL SITE AREAS FOR ALUMINA-FROM-KAOLIN FACILITY

Criteria for Selection

The primary consideration in the selection of a site for an alumina-from-kaolin facility must be whether or not there is sufficeint ore in the area of a grade that will warrant its use for the production of alumina. Current thinking is that 150 million to 500 million contiguous short tons of kaolin will be required for an alumina-from-kaolin facility. The grade of this material should be relatively low in iron, preferably less than 1%. However, clays that may run as high as 5% to 6% iron are considered usable by some companies.

The second requirement for a site is that there is sufficient water to operate an alumina-from-kaolin facility. Current estimates range from three million to 25 million gallons per 24-hour day. The 25 million gallon estimate would be for an evaporative crystallization type plant, for which a lot of cooling water would be required. A production level of a million annual short tons of alumina would require this much water. Initially, a great deal less water would be required in any plant.

A third consideration would be the availability of surface transportation: rail, highway, and, if possible, water.

A fourth, but by no means less important, consideration is the environmental impact of an alumina-from-kaolin facility on both urban and rural areas.

General Areas of Potential Sites

Based on a consideration of these criteria, four general areas of potential sites have been identified in Georgia. These areas are shown on Map 1 and are described below:

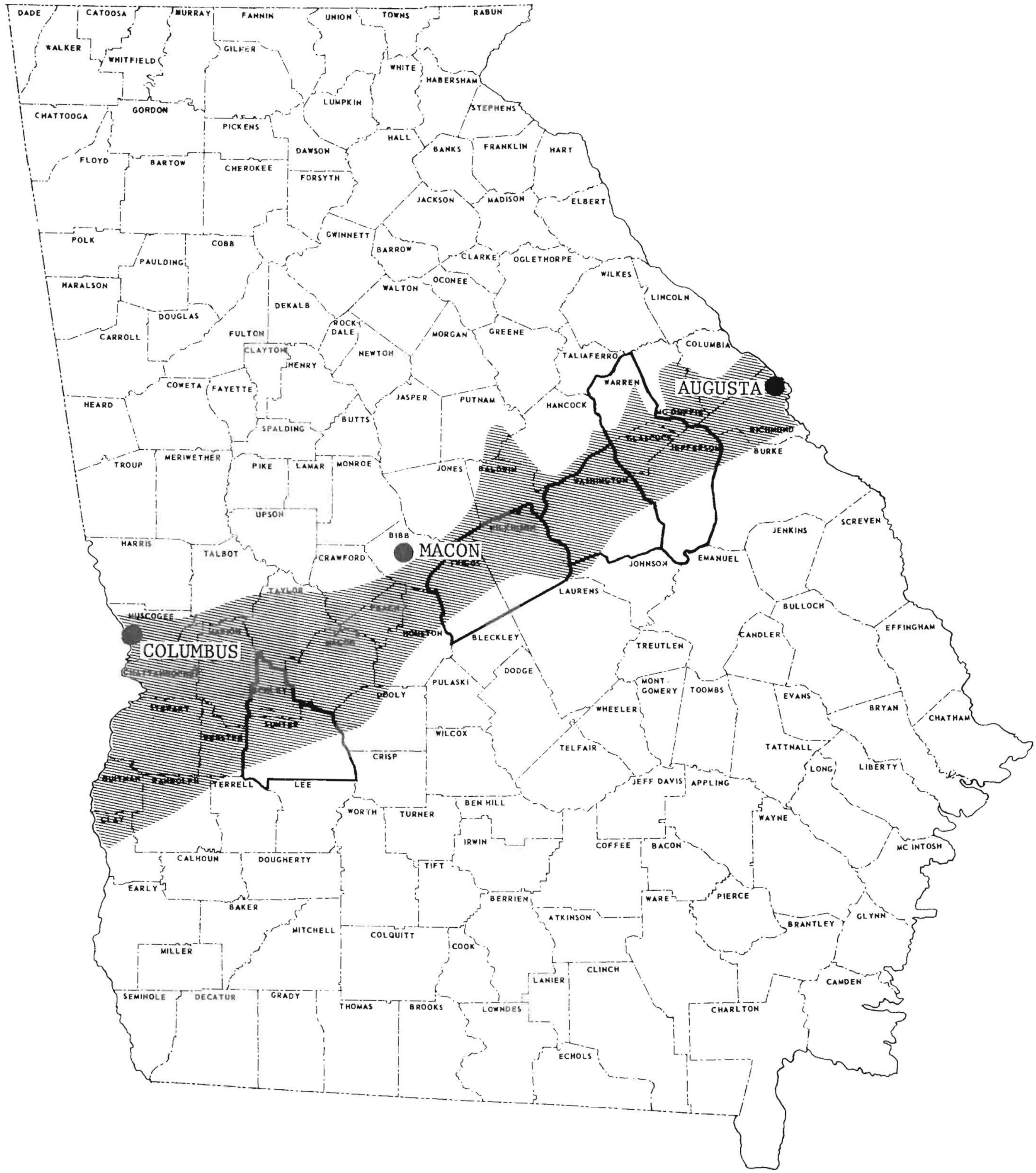
1. A 20-mile radius of Wrens, which would include portions of Jefferson, Glascock, and Warren counties and possibly some of McDuffie County.

2. A 20-mile radius of Sandersville, which would include Washington County alone.

3. A 20-mile radius of McIntyre, which would include portions of Twiggs and Wilkinson counties and possibly some of Baldwin County.

Map 1

LOCATION OF KAOLIN BELT IN GEORGIA



4. A 20-mile radius of Andersonville, which would include portions of Sumter and Schley counties.

The appendix contains detailed maps of the above four site areas. Below is a summary of information that may be of interest in the choice of a site for an alumina-from-kaolin facility.

The Wrens Area. The Wrens area contains a kaolin body that is approximately 30-35 feet thick, five miles wide, and about 20 miles long, with an estimated reserve in excess of three billion short tons. The estimated grade of this clay is an average of 33% Al_2O_3, less that 1% iron, approximately 2% titanium (TiO_2), and moderate to very minor amounts of alkaline metals. The overburden ratios range from near zero to perhaps six to one in some of the more hilly areas of the counties involved. The clay body itself lies essentially flat, with the topography of the area rolling, so that in near stream bottoms the ratio of overburden will be small, whereas on the tops of the hills it will be fairly large. The overall ratio in the area is considered to be within a working range. Reserve estimates are based on a maximum mining depth of 200 feet, although kaolin may be found at greater depths.

Water is scarce in the northern portion of the Wrens area. The amount of water needed as indicated above will vary accoridng to the process used and the size of the plant. The general condition being sought is a groundwater well of 2,000 gallons per minute or more, which can be drilled within a reasonable radius of other wells, so that the drawdown factor will not mitigate against the use of such water. In the Wrens area, water of such amounts and of reasonable good grade is not known to be found east of Georgia Highway 16, nor very much north of the Jefferson-Glascock County line. There is an area with numerous artesian springs in the central part of Jefferson County near Omaha Springs. West of this area water becomes scarce. An example is Edge Hill. Until wells are drilled in this area, it is not possible to know how far south into Jefferson County it will be necessary to go to get the requisite water for a plant in the Wrens area.

The Wrens area is well served by one railroad system, a subsidiary of the Southern Railway System, which goes up the eastern side of Glascock County west of the Warren County line. Western Glascock County would require a spur from this rail line. Highway facilities are good. U. S. Highway 1 runs through the area, coming from Augusta down through Wrens and south through Louisville. State highways are well developed and surfaced. The nearest water transportation would be on the Savannah River, where nine-foot channels are reported to be maintained into Augusta. Near Sylvania, farther down the river, channels as deep as 20 to 30 feet are found.

All envisioned environmental problems are currently being successfully dealt with by present kaolin mining and/or chemical processing plants in the area. Any new industry also will have to meet the Environmental Protection Division's regulations for the protection of the environment.

The Sandersville, Washington County Area. Sandersville is a center for the traditional kaolin industries and has in the past been the northeastern extension of such an industry, when kaolin was mined principally between Huber and Sandersville.

The Sandersville area has several bodies of clay which meet the criterion of 150 million contiguous short tons. They may be under several ownerships or under one ownership. The ore grades of clay found in the Washington County area are essentially the same as the Wrens area; namely, low iron and titanium and traces to minor amounts of alkaline metals. Water in the Sandersville area is much more abundant than in the Wrens area, and sufficient water is believed to be available for an alumina-from-kaolin facility.

Two railroads are in the area. One, the Sandersville Railroad, runs from Sandersville southward to the Central of Georgia Railroad, which is a division of the Southern Railway System. The Sandersville Railroad is privately owned, and the owners have indicated a willingness to run spur lines out of Sandersville to an alumina-from-kaolin facility should it be in an area that they could serve. The Central of Georgia Railway enters the county from the direction of Louisville from the east and leaves the county on the west at Oconee, where it crosses the Oconee River. Spur lines can be made available into most areas where sufficient clay for an alumina-from-kaolin facility is found.

No environmental problems of consequence should be anticipated.

The McIntyre Area. McIntyre is also in the traditional clay area, where such companies as the Huber Corporation at Huber, the Georgia Kaolin Company at Dry Branch, the Freeport Company at Gordon, and the Englehart Minerals and Chemicals Company at McIntyre all operate. Most of the so-called white clays of the area have been taken for conventional kaolin use and can command a much higher price than can be realized from an alumina venture. The best information concerning the clays of the McIntyre area is that the clays that would be available for an alumina industry in contiguous bodies of the amount previously mentioned probably would be higher in iron and possibly higher in silica than the clay farther northeast. This is not to say that clays which would be usable for alumina are not available, but rather that the iron content may run somewhat higher.

Water is considered abundant in this area, and there should be no problem in providing sufficient water for an alumina-from-kaolin facility. The area is served by the Central of Georgia Railway, which enters from the east at Oconee, going westward and swinging northward up through Macon. Highways are adequate, and no environmental problems of consequence would be anticipated.

The Andersonville Area. Andersonville, in the southwest end of the kaolin belt, is not known to contain contiguous kaolin bodies of sufficient size to be used as an ore of aluminum. Chemical grade bauxite and refractory grade kaolin are mined in the area. The area has adequate to abundant water and is well served by railways. Since the Chattahoochee River is navigable from Columbus south, the area has been included to call attention to the favorable location in relation to the Gulf of Mexico water transportation. New clay discoveries or new technology could make this an area of interest in the future.

As a general statement, from the Wrens area southwestward the body of clays become generally smaller and more pocketed and, after crossing the Oconee River, the larger bodies are usually of lower grade. It also should be noted that specific clay bodies are all privately owned. In most of these areas, the control is a checkerboard of ownerships or leases by either kaolin companies or, in some instances, primary aluminum companies. Anyone seeking to enter the area will have to deal with private ownership and probably existing kaolin companies in order to obtain the required reserves. There are some private ownerships and some paper companies reported to have reserves not under control of the kaolin companies, but the knowledge and information is proprietary and, hence, specifics are not available.

APPENDIX

Appendix

DETAILS OF ALUMINA-FROM-KAOLIN SITE AREAS

Appendix Maps 1, 2, 3, and 4 provide geographic detail of four potential site areas in Georgia for an alumina-from-kaolin facility.

All of Georgia is covered by contiguous planning and development commissions. Abundant detailed information is available from these commissions. The name and address of the commission for each site area is given below:

Wrens Area

Jefferson, Glascock, and Warren Counties

Central Savannah River Area Planning and Development Commission
P. O. Box 2800
Augusta, Georgia 30904
(404) 828-2356
Attn: Tim F. Maund, Executive Director

Sandersville Area

Washington County

Oconee Area Planning and Development Commission
P. O. Box 707
Milledgeville, Georgia 31061
(912) 453-5327
Attn: Jim Gentry, Executive Director

McIntyre Area

Twiggs and Wilkinson Counties (Wilkinson is in the Oconee Area)

Middle Georgia Area Planning and Development Commission
711 Grand Building
Macon, Georgia 31201
(912) 744-6160
Attn: Charles H. Howell, Executive Director

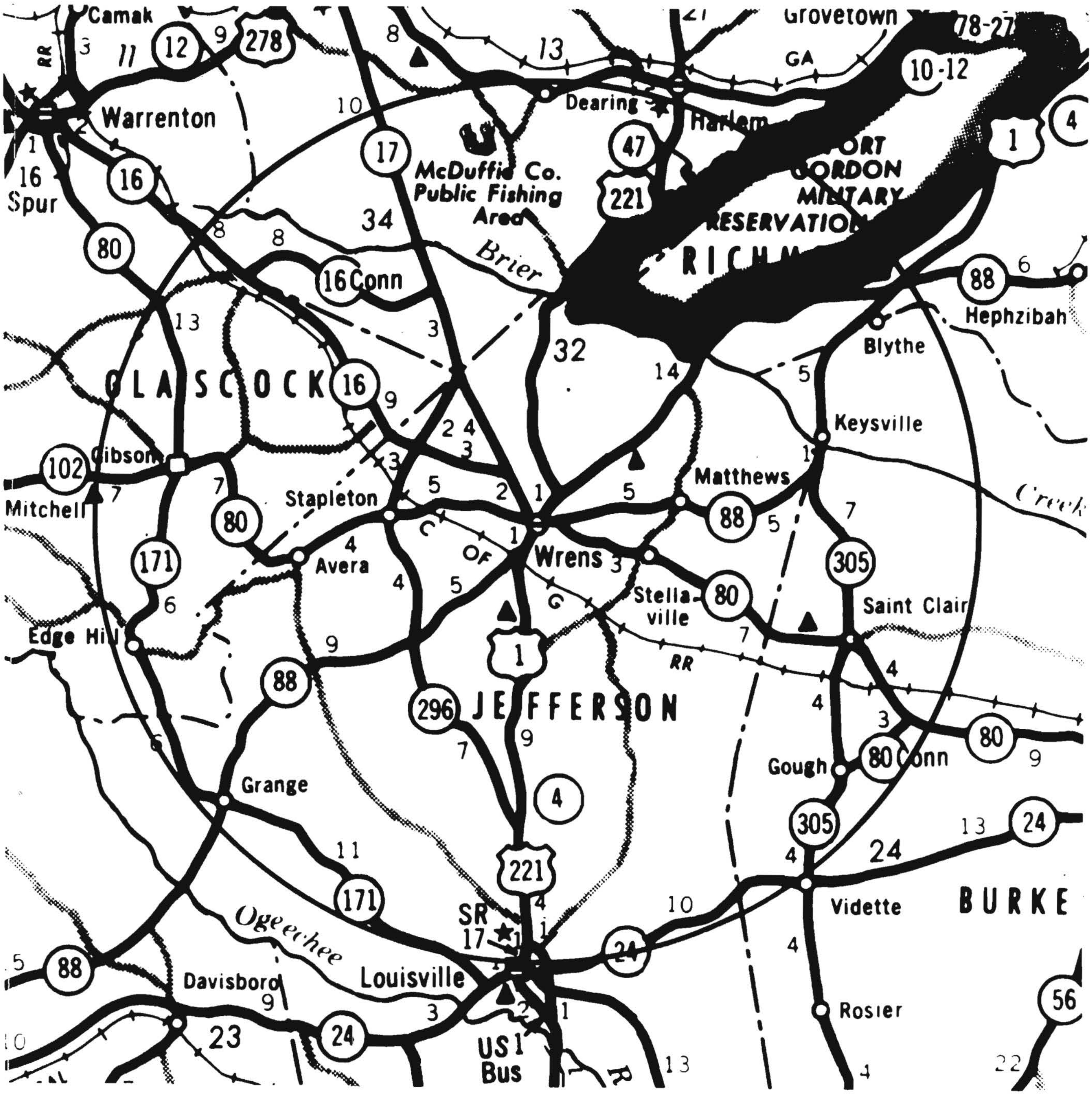
Andersonville Area

Sumter and Schley Counties

Middle Flint Area Planning and Development Commission
P. O. Box 6
Ellaville, Georgia 31806
(912) 937-2241
Attn: Bobby L. Lowe, Executive Director

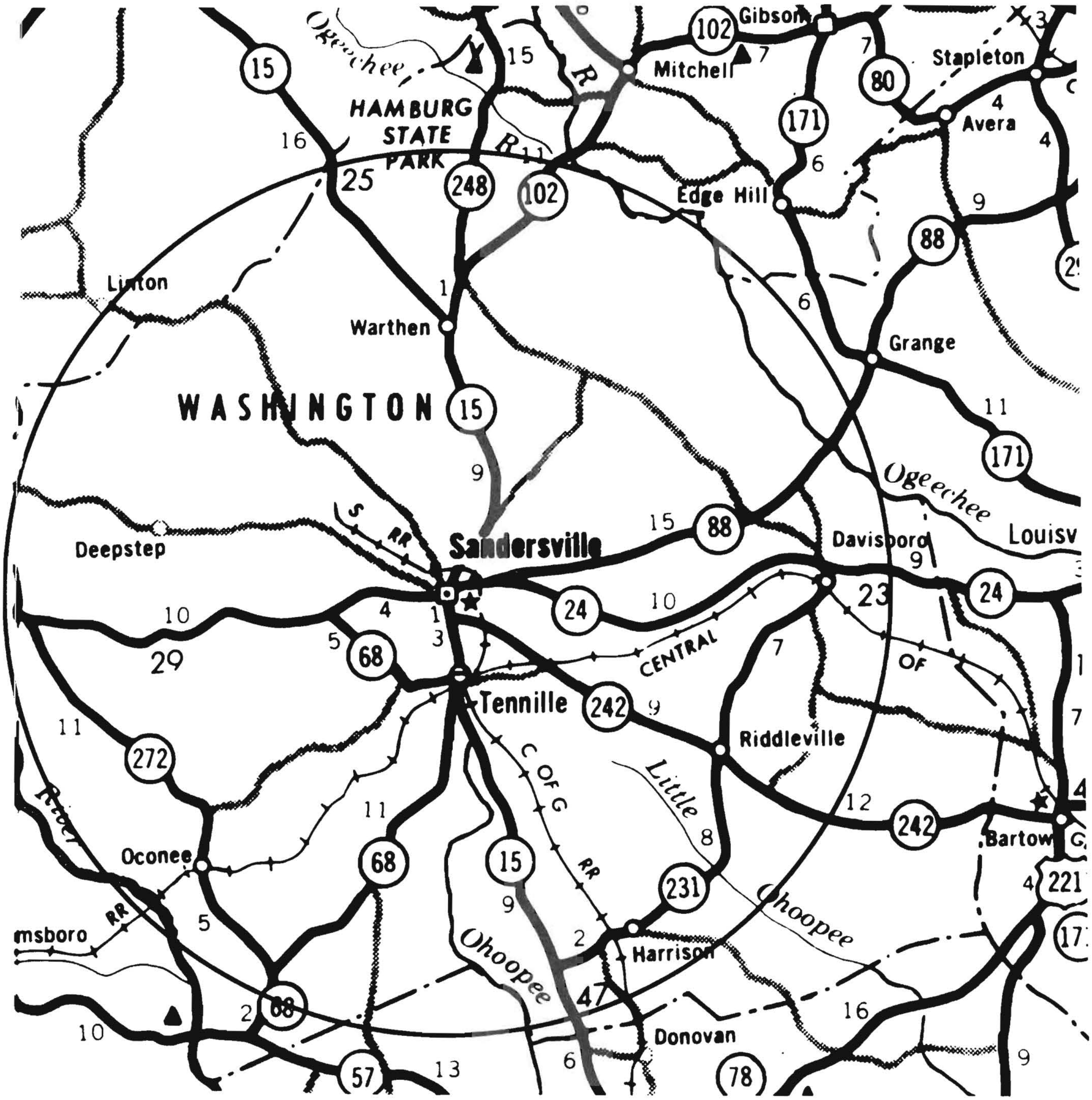
Appendix Map 1

WRENS AREA



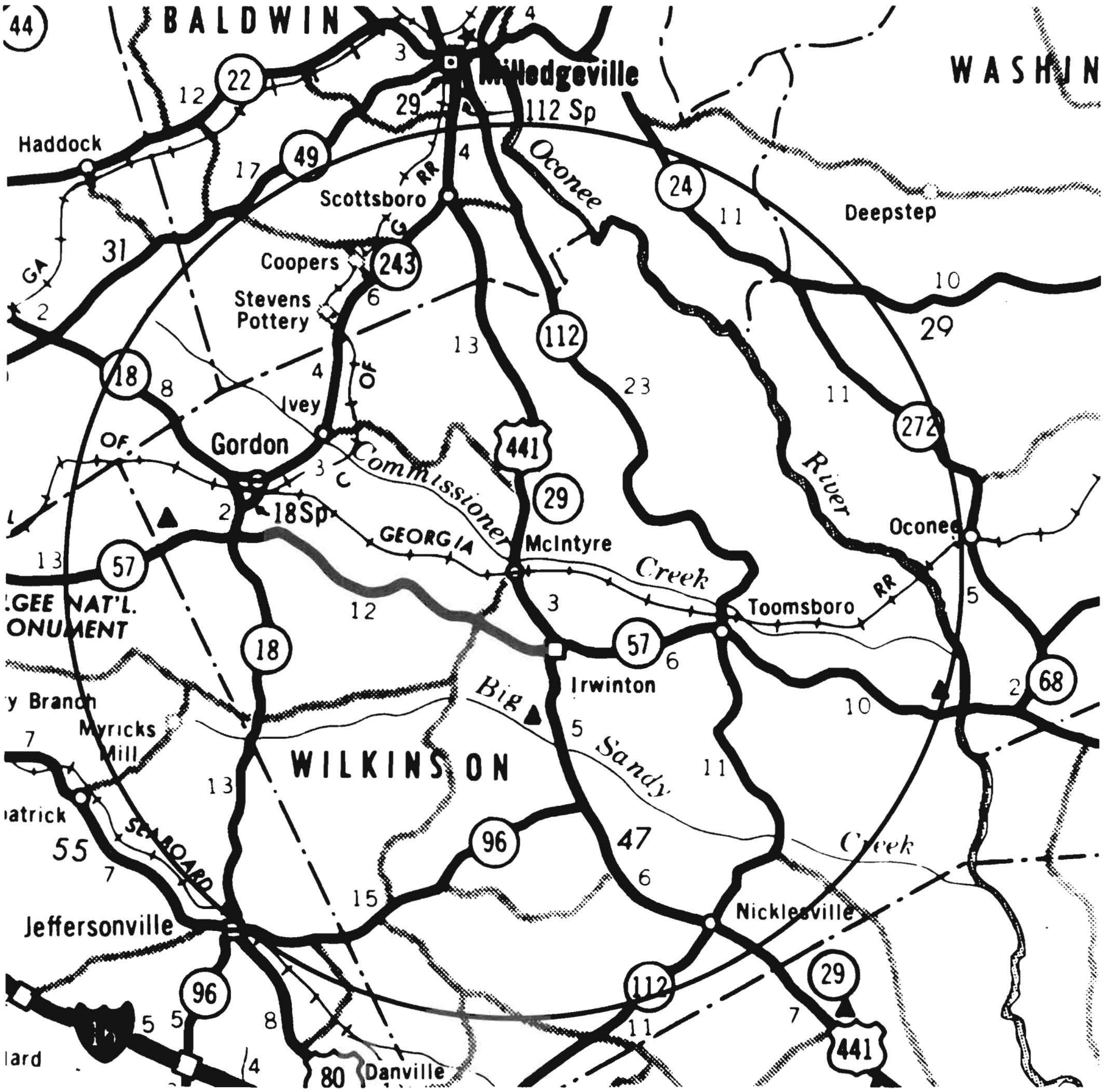
Appendix Map 2

SANDERSVILLE AREA



Appendix Map 3

McINTYRE AREA



Appendix Map 4

ANDERSONVILLE AREA